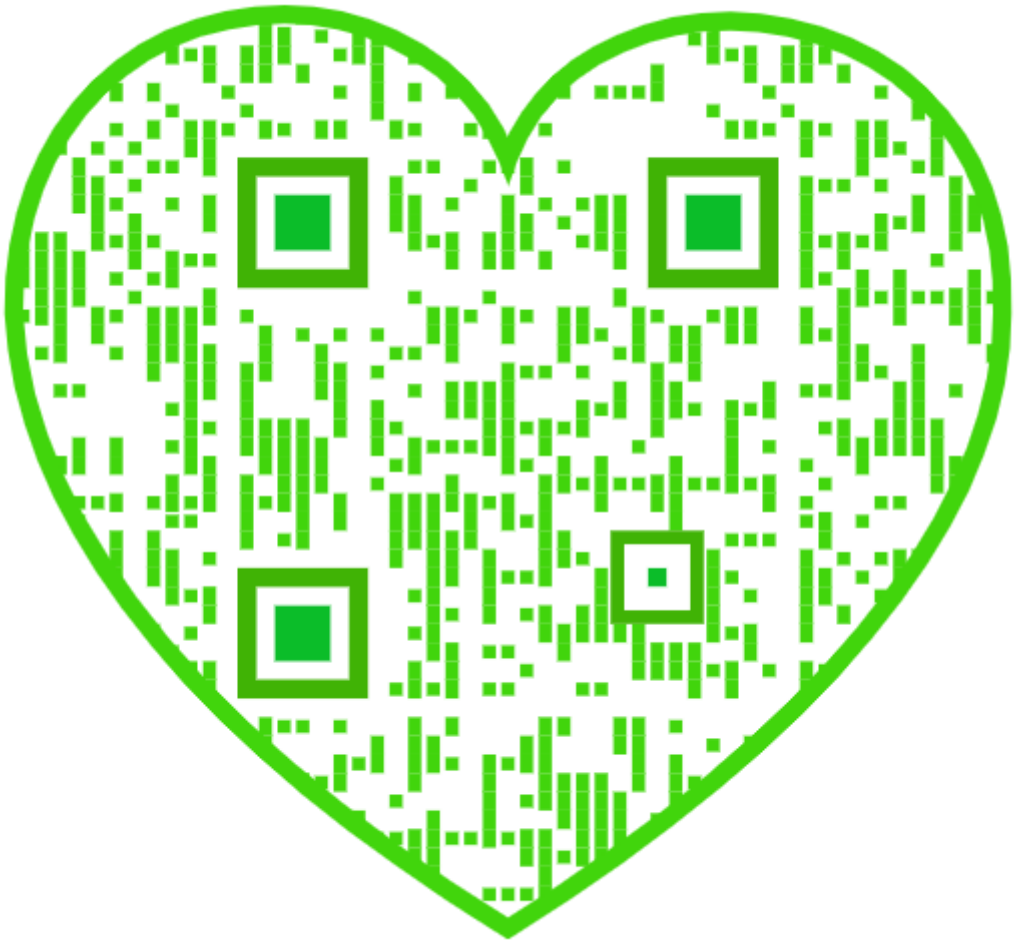
U. S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
FORT SAM HOUSTON, TEXAS 78234

PHARMACEUTICAL CALCULATIONS

SUBCOURSE MD0802

EDITION 100



DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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ADMINISTRATION

Students who desire credit hours for this correspondence subcourse must meet eligibility requirements and must enroll through the Nonresident Instruction Branch of the U.S. Army Medical Department Center and School (AMEDDC&S).

Application for enrollment should be made at the Internet website: http://www.atrrs.army.mil. You can access the course catalog in the upper right corner. Enter School Code 555 for medical correspondence courses. Copy down the course number and title. To apply for enrollment, return to the main ATRRS screen and scroll down the right side for ATRRS Channels. Click on SELF DEVELOPMENT to open the application and then follow the on screen instructions.

In general, eligible personnel include enlisted personnel of all components of the U.S. Army who hold an AMEDD MOS or MOS 18D. Officer personnel, members of other branches of the Armed Forces, and civilian employees will be considered eligible based upon their AOC, NEC, AFSC or Job Series which will verify job relevance. Applicants who wish to be considered for a waiver should submit justification to the Nonresident Instruction Branch at e-mail address: accp@amedd.army.mil.

For comments or questions regarding enrollment, student records, or shipments, contact the Nonresident Instruction Branch at DSN 471-5877, commercial (210) 221-5877, toll-free 1-800-344-2380; fax: 210-221-4012 or DSN 471-4012, e-mail accp@amedd.army.mil, or write to:

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CORRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0802

PHARMACEUTICAL CALCULATIONS

INTRODUCTION

One of the most important areas of study for the pharmacy specialist is pharmaceutical calculations. A person might know a great deal about pharmacology, but if he cannot perform a pharmaceutical calculation, that knowledge cannot be applied in a practical way. To prepare and dispense medications, you must be capable of performing a variety of pharmaceutical calculations. You must be constantly aware of one fact-an error made in a dosage calculation can harm a patient. The study of this subcourse will help give you the knowledge and skill required to perform many types of dosage calculations.

This subcourse is designed to focus on the systems of weights and measures commonly used in the pharmacy. Examples in the text include drugs actually dispensed in outpatient pharmacy settings.

Learning pharmaceutical calculations is like building a house; one part is dependent on the other and a good firm foundation supports it all. Memorizing the formulas and equivalents, developing a well-rounded knowledge of basic mathematics, and practicing what you are learning (that is, solving practice problems) will help you successfully complete this subcourse. Although not required, it is advisable for you to have completed Subcourse MD0801, Prescription Interpretation, before attempting this subcourse.

As you study this subcourse you will notice that practice problems are provided at the end of each section. It is important that you solve these practice problems before you go to the next section. Furthermore, you should complete each practice problem before you attempt to take the final examination.

Subcourse Components:

This Subcourse consists of 3 lessons and an examination. The lessons are:

Lesson 1. Pharmaceutical Calculations I.

Lesson 2. Pharmaceutical Calculations II.

Lesson 3. Pharmaceutical Calculations III.

Credit Awarded:

Upon successful completion of this subcourse, you will be awarded 10 credit hours.

Materials Furnished:

Materials provided include this booklet, an examination answer sheet, and an envelope. Answer sheets are not provided for individual lessons in this subcourse because you are to grade your own lessons. Exercises and solutions for all lessons are contained in this booklet. You must furnish a #2 pencil.

Procedures for Subcourse Completion:

You are encouraged to complete the subcourse lesson by lesson. When you have completed all of the lessons to your satisfaction, fill out the examination answer sheet and mail it to the U.S. Army Medical Department Center and School along with the Student Comment Sheet in the envelope provided. *Be sure that your social security number is on all correspondence sent to the U.S. Army Medical Department Center and School*. You will be notified by return mail of the examination results. Your grades on the exam will be your rating for the subcourse.

Study Suggestions:

Here are some suggestions that may be helpful to you in completing this subcourse.

Read and study each lesson carefully.

Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

After completing each set of lesson exercises, compare your answers with those on the solutions sheet which follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

As you successfully complete each lesson, go on to the next. When you have completed all of the lessons, complete the examination. Mark your answers in this booklet; then transfer your responses to the examination answer sheet using a #2 pencil.

Student Comment Sheet:

Be sure to provide us with your suggestions and criticisms by filling out the Student Comment Sheet (found at the back of this booklet) and returning it to us with your examination answer sheet. Please review this comment sheet before studying this subcourse. In this way, you will help us to improve the quality of this subcourse.

LESSON ASSIGNMENT

LESSON 1	Pharmaceutical Calculations I.
TEXT ASSIGNMENT	Paragraphs 1-1 through 1-44.
LESSON OBJECTIVES	After completing this lesson, you should be able to: 1-1. Perform addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals with 100 percent accuracy. 1-2. Convert from degrees Centigrade to degrees Fahrenheit and vice versa. 1-3. Convert between the various denominations of each of the basic units of the metric system. 1-4. List the conversion factors for the common systems which are most frequently used in the pharmacy. 1-5. Reduce or enlarge pharmaceutical formulas as required in the pharmacy. 1-6. Solve pharmaceutical problems using ratio and proportion and conversion factors. 1-7. Perform pharmaceutical calculations using the metric system.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

PHARMACEUTICAL CALCULATIONS I

Section I. REVIEW OF BASIC MATHEMATICS

1-1. INTRODUCTION

a. Basic arithmetic is always involved in some manner in the solving of pharmaceutical calculations. Perfecting basic mathematical functions will help to attain the goal of 100 percent accuracy desired in pharmacy. Because of the need for 100 percent accuracy, no partial credit will be given for setting a problem up correctly if the answer is incorrect. In pharmacy, the correct answer is more important than the method.

b. Even if the operations performed in this lesson seem overly simple, do them for practice/review. Most of the mistakes made by students taking this subcourse are mistakes in basic mathematics.

1-2. FRACTIONS

Some drugs have dosages expressed in fractions of a grain. Some calculations will involve fractions, and it is important for you to have the ability to perform all mathematical procedures with fractions, whole numbers, and decimals.

a. A fraction consists of two parts: the number above the line is called the NUMERATOR and the number below the line is called the DENOMINATOR.

Example: In the fraction “1/2,” 1 is the NUMERATOR and 2 is the DENOMINATOR.

$$\frac{1 \text{ NUMERATOR}}{2 \text{ DENOMINATOR}}$$

b. Fill in the blanks:

(1) What is the numerator in 3/4? _____

The numerator in 3/4 is 3.

(2) What is the numerator in 9/2? _____

The numerator in 9/2 is 9.

(3) What is the denominator in 7/8? _____

The denominator in 7/8 is 8.

(4) What is the denominator in 12/5? _____

The denominator in 12/5 is 5.

1-3. COMMON DENOMINATORS

a. When fractions have the same number in the denominator, they are said to have COMMON DENOMINATORS. For example: 1/8, 2/8, 5/8, 7/8, and 3/8 all have a COMMON DENOMINATOR of 8.

b. Sometimes there is a need in mathematics to find a common denominator. For example, before fractions may be added or subtracted, the denominators of all the fractions in the problem must be the same.

c. The following rules must be applied when working with fractions:

(1) If the numerator and the denominator of a fraction are multiplied by the same number, the value will not change.

For example: Multiply the numerator and denominator of 1/2 by 2.

$\frac{1}{2} \times \frac{2}{2} = \frac{2}{4}$ then: $\frac{2}{4} \times \frac{2}{2} = \frac{4}{8}$, and so forth.

In this example: 1/2, 2/4, and 4/8 all have the same value.

(2) If the numerator and the denominator of a fraction are divided by the same number, the value of the fraction will not change.

For example:

$\frac{4}{8} \div \frac{2}{2} = \frac{2}{4}$ then: $\frac{2}{4} \div \frac{2}{2} = \frac{1}{2}$, and so forth.

Again: 4/8, 2/4, and 1/2 all have the same value.

d. To find a COMMON DENOMINATOR for the fractions 1/4, 3/8, and 5/16:

(1) Find the largest denominator.

(The largest denominator is 16.)

(2) See if the other denominators can be divided into 16 an even number of times.

(4 and 8 can both be divided into 16 an even number of times.)

(3) Change 1/4 to have a denominator of 16 without changing the value of the fraction.

(a) Multiply the denominator by 4 to make it 16:

$$\frac{1}{4} \times 4 = \frac{\quad}{16}$$

(b) To avoid changing the value, multiply the numerator by 4:

$$\frac{1}{4} \times \frac{4}{4} = \frac{4}{16}$$

(4) Change 3/8 to have the common denominator of 16.

(a) Multiply the denominator 8 by 2 to make it 16.

$$\frac{3}{8} \times \frac{\quad}{2} = \frac{\quad}{16}$$

(b) Because the value of the fraction is to remain the same, multiply the numerator by 2.

$$\frac{3}{8} \times \frac{2}{2} = \frac{6}{16}$$

(5) Therefore, the fractions 1/4, 3/8, and 5/16, when changed to have a common denominator, will be 4/16, 6/16, and 5/16, respectively.

e. When the denominators cannot be divided by the same number, find the smallest denominator into which each of the original denominators will divide evenly. In many cases, a common denominator can be found by multiplying one denominator by the other.

For example: Find the common denominator for 3/4 and 2/3.

(1) Multiply denominators to get a common denominator.

$4 \times 3 = 12$ (Common denominator)

(2) Change the fraction 3/4 to have a denominator of 12.

(a) Multiply the denominator by 3 to make it 12:

$$\frac{3}{4 \times 3} = \frac{\quad}{12}$$

(b) To avoid changing the value, multiply the numerator by 3:

$$\frac{3}{4} \times \frac{3}{3} = \frac{9}{12}$$

(3) Change the fraction 2/3 to have a denominator of 12:

(a) Multiply the denominator by 4 to make it 12:

$$\frac{2}{3 \times 4} = \frac{\quad}{12}$$

(b) To avoid changing the value, multiply the numerator by 4:

$$\frac{2}{3} \times \frac{4}{4} = \frac{8}{12}$$

(4) Therefore, the fractions 3/4 and 2/3, when changed to have the least common denominator, will be 9/12 and 8/12 respectively.

f. For practice, change the following to have common denominators:

(1) 2/3, 5/15, 2/5 _____, _____, _____

(2) 1/12, 5/6 _____, _____

(3) 7/8, 3/6 _____, _____

(4) 3/4, 7/8, 5/16 _____, _____, _____

Answers: (1) 10/15, 5/15, 6/15 (2) 1/12, 10/12
(3) 21/24, 12/24 (4) 12/16, 14/16, 5/16

1-4. LOWEST TERMS

a. A fraction is said to be at its lowest terms when the numerator and the denominator cannot be divided by the same number to arrive at a lower valued numerator and denominator. For example: 3/4 is at its lowest terms because the numerator 3 and the denominator 4 cannot be divided by the same number to lower their values.

b. The fraction 4/8 is not at its lowest terms because the numerator 4 and the denominator 8 can both be divided by the same number to lower their values. The largest number that the numerator 4 and the denominator 8 can be divided by is 4.

$$\frac{4 \div 4}{8 \div 4} = \frac{1}{2}$$

Therefore, 1/2 is 4/8 at its lowest terms.

c. Reduce the following fractions to their lowest terms (if they can be reduced). If they are at their lowest terms, indicate this by placing the same fraction on the answer side of the equal sign:

(1) 7/8 = _____.

(2) 8/20 = _____.

(3) 2/14 = _____.

(4) 25/125 = _____.

(5) 4/5 = _____.

Answers: (1) 7/8 (3) 1/7 (5) 4/5
(2) 2/5 (4) 1/5

1-5. TYPES OF FRACTIONS

a. PROPER Fraction--A PROPER fraction is a fraction that has a numerator smaller than the denominator.

Examples: 1/2, 3/4, 7/8.

b. IMPROPER Fraction--An improper fraction is a fraction that has a numerator larger than the denominator.

Examples: 9/2, 5/3, 3/2.

c. MIXED NUMBER--A mixed number is a combination of a whole number and a proper fraction.

Examples: 1 1/2, 6 1/4, 12 1/2.

1-6. CHANGING AN IMPROPER FRACTION TO A MIXED NUMBER

a. To change an improper fraction to a mixed number:

(1) Divide the denominator into the numerator.

(2) Reduce the remaining fraction to its lowest terms, if possible.

b. For example:

	Improper Fraction	Mixed Number
(1)	3/2 = 3 ÷ 2 =	1 1/2
(2)	5/4 = 5 ÷ 4 =	1 1/4
(3)	9/6 = 9 ÷ 6 =	1 3/6 = 1 1/2*

* The fraction 3/6 was reduced to its lowest terms 1/2.

c. Change the following improper fractions to mixed numbers:

(1) 7/5 = _____ ÷ _____ =_____

(2) 14/3 = _____ ÷ _____ =_____

(3) 22/4 = _____ ÷ _____ =_____

(4) 8/7 = _____ ÷ _____ =_____

Answers: (1) 1 2/5, (2) 4 2/3, (3) 5 1/2, (4) 1 1/7

1-7. CHANGING MIXED NUMBERS TO IMPROPER FRACTIONS

To change a mixed number to an improper fraction, multiply the denominator by the whole number and then add the numerator to this amount. This product will become the new numerator and the denominator will remain the same. For example:

	Mixed Number		Improper Fraction
(1)	1 1/2 =	2 x 1 + 1 =	3/2
(2)	4 7/8 =	8 x 4 + 7 =	3 9/8
(3)	2 3/8 =	8 x 2 + 3 =	9/8

b. Change the following mixed numbers to improper fractions.

(1) 2 3/4 = ____ x ____ + ____ = _____

(2) 12 1/4 = ____ x ____ + ____ = _____

(3) 2 1/9 = ____ x ____ + ____ = _____

(4) 5 4/9 = ____ x ____ + ____ = _____

Answers: (1) 11/4 (2) 49/4, (3) 19/9, (4) 49/9

1-8. ADDING FRACTIONS

a. Use the following steps when adding fractions:

(1) Find a common denominator for all fractions.

(2) Add the numerators only.

(3) The denominator remains the same.

(4) Reduce the answer to lowest terms, if necessary.

b. For example:

		Step 1	Steps 2 and 3	Step 4
(1)	1/2 + 1/4 =	2/4 + 1/4 =	3/4	
(2)	3 /4 + 2/6 =	9/12 + 4/12 =	13/12 =	1 1/12

(3) 1/6 + 1/2 = 1/6 + 3/6 = 4/6 = 2/3

c. Add the following fractions:

(1) 1/3 + 5/12 =____+ ____= ____= ____

(2) 4/3 + 1/4 =____+____ = ____ = ____

(3) 7/8 + 3/4 + 1/12 =____+____ + ____ = ____ = ____

Answers: (1) 3/4, (2) 1 7/12, (3) 1 17/24

1-9. SUBTRACTING FRACTIONS

a. Use the following steps when subtracting fractions:

STEP 1: Find a common denominator.

STEP 2: Subtract the numerators.

STEP 3: The denominators stay the same.

STEP 4: Reduce the answer to lowest terms, if necessary.

b. For example:

		Step 1		Steps 2 and 3	Step 4
(1)	1/2 - 1/4 =	2/4 - 1/4	=	1/4	
(2)	1/3 - 1/4 =	4/12 - 3/12	=	1/12	
* (3)	4/10 - 1/5 =	___ -___	=	___ =	_____

*This problem may be solved by either reducing the fraction 4/10 to 2/5 or by changing the fraction 1/5 to have the common denominator of 2/10.

Answer: 4/10 - 1/5 = 2/5 - 1/5 = 1/5

Answer: 4/10 - 1/5 = 4/10 - 2/10 = 2/10 = 1/5

NOTE: The first method is preferred because you have reduced the 4/10 to 2/5, thereby using the least common denominator and eliminating the reduction to lowest terms in the final answer.

c. Subtract the following fractions:

(1) 3/4 - 1/4 = _____ - _____ = _____ = _____

(2) 3/4 - 1/8 = _____ - _____ = _____ = _____

(3) 5/8 - 4/32 = _____ - _____ = _____ = _____

(4) 7/9 - 2/5 = _____ - _____ = _____ = _____

Answers: (1) 1/2, (2) 5/8, (3) 1/2, (4) 17/45

1-10. MULTIPLYING FRACTIONS

a. Use the following steps when multiplying fractions:

STEP 1: Multiply numerators.

STEP 2: Multiply denominators.

STEP 3: Reduce to lowest terms, if necessary.

b. For example: 1/2 x 1/3 = ___?____

Step (1) Multiply numerators:

1/2 x 1/3 = 1/

Step (2) Multiply denominators:

1/2 x 1/3 = 1/6 (Answer)

Step (3) Reduce to lowest terms, if necessary:

1/6 is at its lowest terms, so, Step 3 is not necessary in this case.

c. For example: 2/3 x 3/4 = ____?___.

(1) 2/3 x 3/4 = 6/

(2) 2/3 x 3/4 = 6/12

(3) 6/12 = 1/2 (Answer)

d. Work the following:

(1) 1/12 x 1/12 = ___?____

(a) 1/12 x 1/12 = __/

(b) 1/12 x 1/12 = /__

(c) ?

(2) 5/6 x 3/4 = _____

(3) 1/12 x 5/6 = _____

* (4) 1 3/4 x 1/6 = _____

*1 3/4 has to be changed to an improper fraction, (7/4), before multiplying.

Answers: (1) 1/144, (2) 5/8, (3) 5/72, (4) 7/24

e. Use the following steps when multiplying a fraction by a whole number:

STEP 1: Change the whole number to a fraction by placing the number over one.

STEP 2: Multiply numerators.

STEP 3: Multiply denominators.

STEP 4: Reduce to lowest terms, if necessary.

f. For example: 7/8 x 20 = _____

(1) Change the whole number to a fraction by placing it over one:

$$7 \times \frac{20}{1} = \_\_\_\_\_$$
8

(2) Multiply numerators:

$$\frac{7}{8} \times \frac{20}{1} = \frac{140}{}$$

(3) Multiply denominators:

$$\frac{7}{8} \times \frac{20}{1} = \frac{140}{8}$$

(4) Reduce to lowest terms:

$$\begin{array}{r} 17.5 \\ 8\overline{)140.0} \\ \underline{8} \\ 60 \\ \underline{56} \\ 40 \\ \underline{40} \\ 0 \end{array}$$

(answer) or 17 1/2

g. Solve the following:

(1) 1/2 x 100 = _____

(a) Change the whole number to a fraction by placing it over one.

(b) Multiply numerators.

(c) Multiply denominators.

(d) Reduce, if necessary.

(2) 1/120 x 80 = _____

(3) 3/4 x 12 = _____

Answers: (1) 50, (2) 2/3, (3) 9

1-11. DIVIDING FRACTIONS

a. Use the following steps when dividing fractions:

STEP 1: Invert the divisor (the number by which you are dividing) and change the division sign to a multiplication sign.

STEP 2: Multiply numerators,

STEP 3: Multiply denominators.

STEP 4: Reduce the answers to lowest terms, if necessary.

b. For example: 1/2 ÷ 1/4 = _____.

(1) Invert the divisor and change the division sign to a multiplication sign:

1/2 x 4/1 = _____

(2) Multiply numerators:

1/2 x 4/1 = 4/

(3) Multiply denominators:

1/2 x 4/1 = 4/2

(4) Reduce to lowest terms:

4/2 = 2/4 = 2 (Answer)

c. Divide the following fractions:

(1) 5/6 ÷ 3/4 = _____

(a) 5/6 x ___= _____

(b) 5/6 x ___= __/

(c) 5/6 x ___= __/__

(d) _____

(2) 1/3 ÷ 1/6 = _____

(3) 5/6 ÷ 1/120 = _____

(4) 1/2 ÷ 3/4 = _____

Answers: (1) 1 1/9, (2) 2, (3) 100, (4) 2/3

d. Practice Problems. The answers to these problems are found at the end of the exercise. Perform the indicated operation:

(1) Add:

(a) 1/2 + 1/6 =_____

(b) 3/4 + 1/2 =_____

(c) 3/8 + 1/2 =_____

(d) 5/6 + 2/5 =_____

(e) 3/8 + 1/3 + 5/24 =_____

(f) 1/2 + 5/8 + 3/4 =_____

(g) 1/18 + 3/4 + 2/9 =_____

(2) Subtract:

(a) 3/7 - 1/21 = _____

(b) 1/20 -1/25 = _____

(c) 1/250 - 1/1000 = _____

(d) 1 - 3/5 = _____

(e) 1/25 - 1/75 = _____

(f) 1 3/8 - 1/4 = _____

(g) 2 3/4 - 1 5/8 = _____

(3) Multiply:

(a) 3/5 x 1/6 =_____

(b) 1/10 x 3/4 =_____

(c) 2/3 x 5/8 =_____

(d) 1/2 x 10 =_____

(e) 1/1000 x 1/10 =_____

(f) 1 1/2 x 3 1/4 =_____

(g) 1/2 x1/4 =_____

(4) Divide:

(a) 1/8 ÷ 1/8 =_____

(b) 1/2 ÷ 1/100 =_____

(c) 1/100 ÷ 1/150 =_____

(d) 10 ÷ 1/120 =_____

(e) 5/6 ÷ 25 =_____

(f) 1/1000 ÷ 1/4 =_____

(g) 7 1/2 ÷ 15 =_____

e. Answers: The first problem in each section will be worked out. Other problems will have the answers only.

(1) Add:

(a) 1/2 + 1/6 = 3/6 + 1/6 = 4/6 = 2/3

(b) 1 1/4

(c) 7/8

(d) 1 7/30

(e) 11/12

(f) 1 7/8

(g) 1 1/36

(reference para 1-8)

(2) Subtract:

(a) 3/7 - 1/21 = 9/21 - 1/21 = 8/21

(b) 1/100

(c) 3/1000

(d) 2/5

(e) 2/75

(f) 1 1/8

(g) 1 1/8

(reference para 1-9)

(3) Multiply:

(a) 3/5 x 1/6 = 3/30 = 1/10

(b) 3/40

(c) 5/12

(d) 5

(e) 1/10,000

(f) 4 7/8

(g) 1/8

(reference para 1-10)

(4) Divide:

(a) 1/8 ÷ 1/8 = 1/8 x 8/1 = 8/8 = 1

(b) 50

(c) 1 1/2

(d) 1,200

(e) 1/30

(f) 1/250

(g) 1/2

(reference para 1-11)

1-12. DECIMALS

Pharmacy uses primarily the metric system of measure, which is a decimal system. Thus, the majority of the calculations will deal with decimals. At times, it is necessary to change a fraction to a decimal to simplify a procedure.

1-13. CONVERTING A FRACTION TO A DECIMAL

a. To convert a FRACTION to a DECIMAL, divide the denominator into the numerator.

For example:

(1) 1/2 = 2/1.0 = 0.5

(2) 1/5 = 5/1.0 = 0.2

(3) 1/3 = 3/1.0 = 0.333

b. Change the following fractions to decimals:

(1) 1/8 = / =

(2) 3/4 = / =

* (3) 25/100 = / =

(4) 1/5000 = / =

***NOTE:** Although 100 may be divided into 25, it is best to reduce the fraction 25/100 to 1/4 and then divide.

$$1/4 = 4\overline{)1.0} = 0.25$$

Answers: (1) 0.125, (2) 0.75, (3) 0.25, (4) 0.0002

1-14. MULTIPLYING A DECIMAL BY A NUMBER THAT IS A MULTIPLE OF 10

a. If a decimal is to be multiplied by a number that is a multiple of ten (10, 100, 1000, and so forth), move the decimal point as many places to the RIGHT as there are zeros in the multiplier.

b. For example: When multiplying 0.2 times 100, move the decimal point one place to the RIGHT for each of the zeros in the multiplier. There are two zeros, therefore the decimal must be moved two places to the right.

$$0.2 \times 100 = 0.20 = 20$$

Examples:

(1)	0.6 x 10 =	6	(4)	6.75 x 10	= 67.5
(2)	0.6 x 100 =	60	(5)	6.75 x 100	= 675
(3)	0.6 x 1000 =	600	(6)	6.75 x 1000	= 6750

c. Work the following:

(1)	0.08 x 100 = _____		(7)	3.68 x 10 =	_____
(2)	0.08 x 1000 = _____		(8)	0.02 x 100 =	_____
(3)	0.75 x 10 = _____		(9)	164.6 x 1000 =	_____
(4)	0.043 x 100 = _____		(10)	64.8 x 100 =	_____
(5)	14.6 x 1000 = _____		(11)	0.0042 x 10 =	_____
(6)	0.14 x 100 = _____		(12)	40 x 10,000 =	_____

Answers: (1) 8 (4) 4.3 (7) 36.8 (10) 6,480
(2) 80 (5) 14,600 (8) 2 (11) 0.042
(3) 7.5 (6) 14 (9) 164,600 (12) 400,000

1-15. DIVIDING DECIMALS BY MULTIPLES OF 10

a. If a decimal is to be divided by a multiple of ten (10, 100, 1000, and so forth), move the decimal point as many places to the left as there are zeroes in the divisor.

b. For example: When dividing 0.2 by 100, move the decimal point one place to the left for each of the zeros in the divisor (the number you are dividing into the other number). There are two zeros, therefore, we move the decimal two places to the left.

$$0.2 \div 100 = 0.00.2 = 0.002$$

Examples:

(1) $5 \div 10 = 0.5$

(2) $5 \div 100 = 0.05$

(3) $5 \div 1000 = 0.005$

(4) $1.8 \div 10 = 0.18$

(5) $1.8 \div 100 = 0.018$

(6) $1.8 \div 1000 = 0.0018$

c. Work the following problems:

(1) $6.2 \div 100 =$_____

(2) $20 \div 10 =$_____

(3) $4.3 \div 1000 =$_____

(4) $0.08 \div 100 =$_____

(5) $0.7 \div 10 =$_____

(6) $12.324 \div 100 =$_____

(7) $65 \div 1000 =$_____

(8) $0.025 \div 10 =$_____

(9) $1.34 \div 1000 =$_____

(10) $65.0 \div 100 =$_____

Answers: (1) 0.062 (2) 2 (3) 0.0043 (4) 0.0008 (5) 0.07 (6) 0.12324 (7) 0.065 (8) 0.0025 (9) 0.00134 (10) 0.65

d. Example problems.

(1) If a pharmacy specialist is to make 1000 capsules of a drug with each capsule containing 0.005 grams of the drug, how many grams of the drug would he use?

Answer: _____grams

(2) If a pharmacist has 27 grams of a drug that will be used in a formula to make 1000 capsules, how many grams of the drug will be in each capsule?

Answer: _____grams

(3) How many grams of zinc oxide would be required to make 100 four-ounce jars of ointment with each jar containing 19.2 grams of zinc oxide?

Answer: _____grams

Answers: (1) 5 grams, (2) .027 grams, (3) 1,920 grams.

1-16. ADDING DECIMALS

a. When adding decimals, line up the decimal points and then add as with whole numbers.

For example:

$$\begin{array}{r} 0.2 \\ 0.07 \\ +\ \underline{8.6} \\ 8.87 \end{array}$$

0.2 + 0.07 + 8.6 =

NOTE: The decimal in the answer falls directly in line with the other decimals.

b. Work the following:

(1) 16.3 + 0.14 + 0.001 = _____

(2) 0.4 + 0.23 + 0.001 = _____

(3) 0.002 + 1.432 + 0.01 = _____

(4) 111 + 6.12 + 0.0007 = _____

Answers: (1) 16.441, (2) 0.631, (3) 1.444, (4) 117.1207

1-17. SUBTRACTING DECIMALS

a. When subtracting decimals, line up the decimal points and subtract as with whole numbers.

For example: 5.345 - 0.897 =

```
  5.345
- 0.897
  4.448
```

NOTE: The decimal point in the answer falls directly in line with the other decimals.

b. Work the following:

(1) 2.149 - 0.872 = _____

(2) 0.65 - 0.04 = _____

(3) 3.402 - 1.65 = _____

(4) 18.004 - 1.08 = _____

(5) 1.87 - 0.96 = _____

Answers: (1) 1.277, (2) 0.61, (3) 1.752, (4) 16.924, (5) 0.91

1-18. MULTIPLYING DECIMALS

a. Use the following steps when multiplying decimals:

STEP 1: Multiply as with whole numbers.

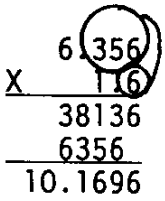
STEP 2: Move the decimal point in the answer one place to the left for each number to the right of a decimal in each of the numbers being multiplied.

b. For example: 6.356 X 1.6 = _____

(1) Multiply as with whole numbers:

```
  6.356
X 1.6
38136
6356
101696
```

(2) Move the decimal point in the answer one place to the left for each number that is to the right of a decimal in each of the numbers being multiplied:



NOTE: There are a total of four numbers to the right of decimals in the numbers being multiplied.

NOTE: The decimal was moved as many places to the left.

c. Multiply the following:

(1) 735.04 X 0.05 =_____

(2) 12.75 X 4.34 =_____

(3) 4.10 X 3.6 =_____

(4) 15.42 X 11.25 =_____

Answers: (1) 36.752, (2) 55.335, (3) 14.76, (4) 173.475

1-19. DIVIDING DECIMALS

a. Use the following steps when dividing decimals:

STEP 1: Set up to divide, ensuring that the number after the division sign (÷) is the divisor (the number to be divided into the other number).

STEP 2: Move the decimal point in the divisor as many places to the right as is necessary to make it a whole number.

STEP 3: Move the decimal point in the dividend (the number being divided) the same number of places to the right.

STEP 4: Place the decimal in the answer directly above the decimal in the dividend and complete the division.

b. For example: 12.5 ÷ 0.625 = _____

(1) Set up to divide ensuring that the number after the division sign is the divisor:

$$0.625\overline{)12.5}$$

(2) Move the decimal point in the divisor as many places to the right as is necessary to make it a whole number:

$$625\ \overline{)12.5}$$

* (3) Move the decimal point in the dividend the same number of places to the right:

***NOTE:** It took a three decimal place move to make the divisor (0.625) a whole number in step 2. Because the decimal had to be moved three places to make the divisor a whole number, the decimal in the dividend must also be moved three places to the right.

$$625\ \overline{)12500.}$$

(4) Place the decimal in the answer directly above the decimal in the dividend and complete the division:

```
   ___20.
625 /12500.
    -1250_
      0
```

c. Solve the following:

(1) 6.69 ÷ 0.3 =_____

(2) 50.5 ÷ 0.05 =_____

(3) 3750 ÷ 0.2 =_____

(4) 437.5 ÷ 0.025 =_____

Answers: (1) 22.3, (2) 1010, (3) 18,750, (4) 17,500

d. Practical exercises. Perform the indicated operations.

(1) 416.38 + 3.24 + 41.6 =_____

(2) 300 - 1.3 =_____

(3) 25 x 1000 =_____

(4) 5.74 ÷ 1000 =_____

(5) 0.47 x 0.23 =_____

(6) 1.234 ÷ 0.61 =_____

(7) 219.56 x 100 =_____

(8) 1.1010 - 0.8987 =_____

(9) 0.0908 ÷ 4.5 =_____

(10) 387 x 10 =_____

(11) 63.04 - 1.89 =_____

(12) 0.15 + 2.8 + 0.024 =_____

(13) 10 - 9.999 =_____

(14) 1.35 x 0.005 =_____

(15) 16 ÷ 0.25 =_____

(16) 6.9042 ÷ 11.1 =_____

(17) 2.48 x 1000 =_____

(18) 100.4 ÷ 1.004 =_____

(19) 456.78 - 34.78 =_____

(20) 35.4 ÷ 100 =_____

e. Answers. Below are the answers to the practical exercises:

(1) 461.22 (para 1-16)
(2) 298.7 (para 1-17)
(3) 25,000 (para 1-14)
(4) 0.00574 (para 1-15)
(5) 0.1081 (para 1-18)
(6) 2.023 (para 1-19)
(7) 21,956 (para 1-14)
(8) 0.2023 (para 1-17)
(9) 0.0202 (para 1-19)
(10) 3,870 (para 1-14)
(11) 61.15 (para 1-17)
(12) 2.974 (para 1-16)
(13) 0.001 (para 1-17)
(14) 0.00675 (para 1-18)

(15) 64 (para 1-19)
(16) 0.622 (para 1-19)
(17) 2,480 (para 1-14)
(18) 100 (para 1-19)
(19) 422.0 (para 1-17)
(20) 0.354 (para 1-15)

1-20. BASIC ALGEBRAIC PRINCIPLES

a. Algebra is the branch of mathematics used to analyze the relationship of numbers and concepts with the use of formulas and equations. Algebra is used to find the value of an unknown factor that is related to known factors. The unknown factor is usually given the value of "X."

For example: Five times some unknown number is equal to 20. To set this up as an equation with the unknown factor being X:

$$5\,(X) = 20$$

b. If two quantities are equal, you may perform identical mathematical functions to both sides of the equal sign without changing the fact that both sides are equal. If the factors on one side of the equal sign are multiplied or divided by a number and the same operation is done to the other side, the resulting factors will be equal. To solve for X, the X must be isolated on one side of the equal sign. This may usually be accomplished by dividing both sides by the number in front of X. This number is called the coefficient of X.

$$\frac{\cancel{5}}{\cancel{5}}X = \frac{20}{5}$$

NOTE: The 5's above and below the line on the left side of the equal sign cancel leaving:

$$X = \frac{20}{5}$$

c. In general, X can be found by dividing the coefficient of X into the number on the opposite side of the equal sign.

d. If the coefficient of X is a fraction, either of the following methods may be used:

(1) Divide both sides of the equation by the coefficient of X:

For example: $\frac{1}{2}X = 20$

$$\frac{\frac{1}{2}X}{\frac{1}{2}} = 20 \div \frac{1}{2}$$

NOTE: The 1/2's cancel on the left side.

Then: $X = \frac{20}{1} \times \frac{2}{1}$

$X = 40$

(2) When the coefficient of X is a fraction, multiply both sides of the equal sign by the denominator of the coefficient:

For example: $\frac{1}{2}X = 20$

$$(2)\ \frac{1}{2}X = 20\ (2)$$

NOTE: The 2's will cancel on the left side of the equal sign leaving:

$X = 20\ (2)$

$X = 40$

e. Example problem:

Multiply both sides of the equation by the denominator of the fraction:

$$(8)\ \frac{5}{8}X = 200\ (8)$$

NOTE: The 8's cancel on the left side leaving:

$$5X = 1600$$

$$X = \frac{1600}{5}$$

$$X = 320$$

f. Practical Exercises. Solve for X and check your answers in paragraph 1-20g.

(1)	5 X = 240	(7)	0.25 X = 100
(2)	2 X = 660	(8)	8 X = 14
(3)	30 X = 6	(9)	0.02 X = 100
(4)	50 X = 1140	(10)	5 X = 120
(5)	1/500 X = 0.5	(11)	1/8 X = 16
(6)	3/4 X = 75	(12)	1/1000 X = 1

g. Answers. Below are the answers to practical exercises (reference paragraph 1-20).

(1)	48	(7)	400
(2)	330	(8)	1.75
(3)	0.2	(9)	5000
(4)	22.8	(10)	24
(5)	250	(11)	128
(6)	100	(12)	1000

Section II. TEMPERATURE CONVERSIONS

1-21. INTRODUCTION

a. There are two different scales used for measuring temperature. The Fahrenheit scale, which is the most common, has the boiling point of water as 212ºF and the freezing point of water as 32ºF. The Centigrade (Celsius) scale, which is used in the sciences, has the boiling point of water as 100ºC and the freezing point of water as 0ºC.

b. The storage temperature of drugs that require refrigeration is normally expressed in degrees Centigrade. Many of the temperature gauges used in refrigerators are graduated in degrees Fahrenheit. At times, it is necessary to calculate a change from one scale to the other.

1-22. FORMULA

The following formula works for converting both ways; that is, conversions can be made from Fahrenheit to Centigrade or from Centigrade to Fahrenheit using this formula:

$$5F = 9C + 160$$

1-23. ALGEBRAIC PRINCIPLES INVOLVED

To work the above formula, the following algebraic principles must be understood:

a. When bringing a number from one side of an equation to the other (transposition), the sign must be changed. For example: To place the +l60º on the left of the formula, simply change it to a -160 and transpose:

$$5F = 9C + 160$$

$$5F - 160 = 9C \text{ (Both formulas have equal value)}$$

b. When adding like signs, simply add and keep the same sign. For example:

$$(+160) + (+100) = +260$$

$$(-160) + (-100) = -260$$

c. When adding unlike signs, subtract the smaller value from the larger and take the sign of the larger. For example:

(+160) + (-100) = +60

(-160) + (+100) = -60

d. When multiplying or dividing, if the signs are alike the answer will always be plus. If the signs are different, the answer will always be minus. For example:

(1) Multiplication

+25	-25	-25	+25
x +5	x –5	x +5	x - 5
+125	+125	-125	-125

(2) Division

+5	_+5_	_+5_	_-5_	_-5_
+5	/+25	-5/-25	-5/+25	+5/-25

1-24. SAMPLE PROBLEMS

a. Convert 140ºF to ºC:

5F	=	9C	+	160º	(formula)
5(140º)	=	9C	+	160º	(substitution)
700º	=	9C	+	160º	(multiplication)
700º - 160º	=	9C			(transposition)
540º	=	9C			(subtraction)
60º	=	C			(division)

b. Convert - 49ºF to °C:

5F	=	9C	+	160º	(formula)
5(-49)	=	9C	+	160º	(substitution)
-245º	=	9C	+	160º	(multiplication)
-245º- l60º	=	9C			(transposition)

-405º	=	9C			(addition)
-45º	=	C			(division)

c. Convert 40ºC to F:

5F	=	9C	+	160º	(formula)
5F	=	9(40º)	+	l60º	(substitution)
5F	=	360º	+	160º	(multiplication)
5F	=	520º			(addition)
F	=	104º			(division)

d. Practical Problems. Solve the following:

(1) Convert -40ºC to ºF.

(2) Convert 2ºC to ºF.

(3) Convert 98.6ºF to ºC.

e. Answers. Below are the answers to practical problems. (Reference paragraph 1-23).

(1) -40ºF, (2) 35.6ºF, (3) 37ºC

Section III. PRESCRIPTION INTERPRETATION

1-25. INTRODUCTION

NOTE: For a thorough review of prescription interpretation, see Subcourse MD0801.

Many of the calculations performed in the pharmacy rely on the pharmacy technician's ability to interpret a prescription. Two significant factors, in regard to prescription interpretation, are the METRIC LINE and ROMAN NUMERALS. Most of the weighing and measuring is done in the metric system with:

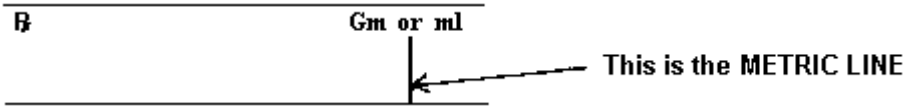
a. Solids being weighed in the unit of grams or parts of a gram.

b. Liquids being measured in milliliters or parts of milliliters.

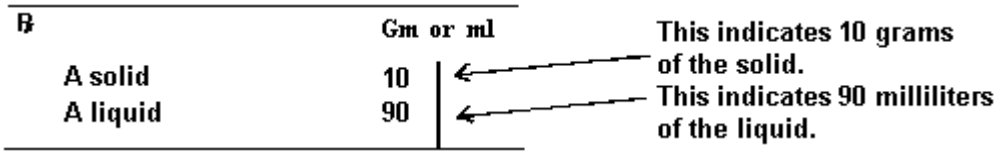
1-26. METRIC LINE

a. The METRIC LINE acts as a decimal point for both grams and milliliters. The unit gram is indicated if the substance is a solid and milliliters if the substance is a liquid.

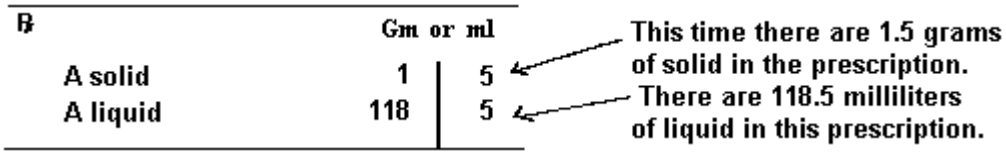
(1) Prescription #1.



(2) Prescription #2.



(3) Prescription #3.



(4) Prescription #4.

How much of each ingredient is in this prescription? Indicate proper units.

_____solid

_____liquid

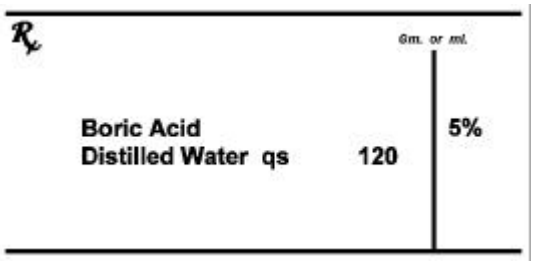
Answers: 0.001 gram of solid; 0.01 milliliter of liquid.

NOTE: The metric line pertains to grams and milliliters only. When any other unit designation follows an amount on the prescription, the metric line must be ignored for that substance. For example:

(5) Prescription #5.

In this case, there is a unit designation of grain following the 5 so the metric line should be ignored. The strength of the tablets *is not* 0.5 grains, but is 5 grains because the metric line only applies to grams and milliliters.

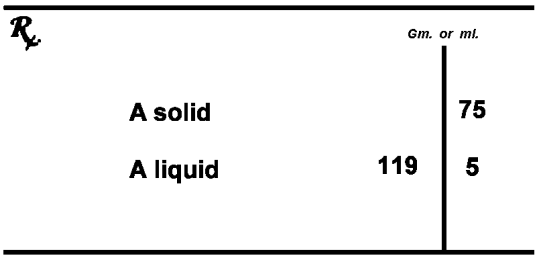
(6) Prescription #6.



The 5% indicates 5% because the metric line is to be ignored when units are designated. The 120 indicates 120 milliliters because it is a liquid and no units are given.

b. Fill in the blank:

(1)

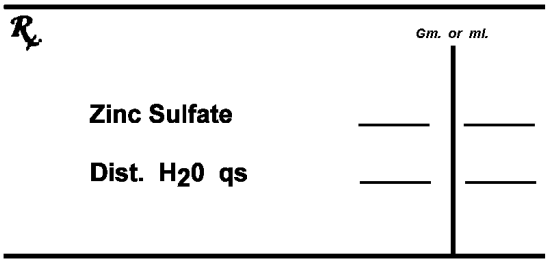


Place amount and unit in the blank.

_____ solid

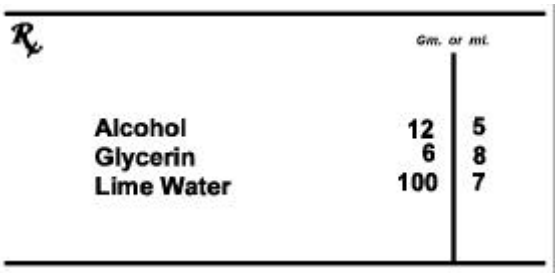
_____ liquid

(2)



Indicate on this prescription 4.8 grams of zinc sulfate and qs to 120 milliliters with distilled water.

(3)



Place the amount and unit in each blank.

_____ alcohol
_____ glycerin
_____ lime water

c. Answers:

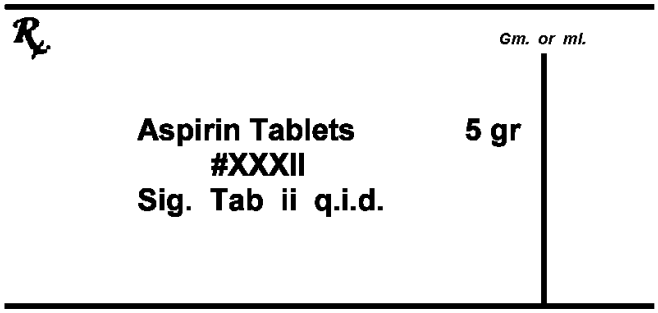
(1) 0.75 gram of solid and 119.5 milliliters of liquid

(2) Zinc sulfate 4 8 and distilled water qs 120 0

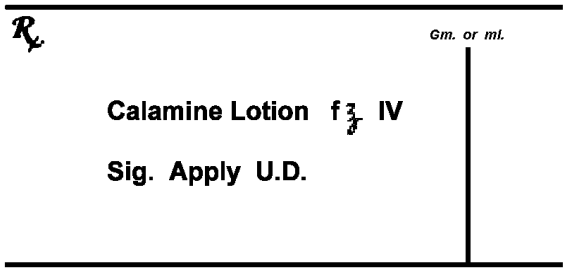
(3) 12.5 milliliters alcohol, 6.8 milliliters glycerin and 100.7 milliliters lime water.

1-27. ROMAN NUMERALS

a. Roman numerals are sometimes used in place of Arabic numbers on a prescription to designate the number of tablets or the number of fluid ounces of a liquid to be dispensed. For example:



b. In the above prescription, the Roman numeral XXXII as written below the dosage form (aspirin tablets-5 gr) indicates the number of tablets to be dispensed. Roman numerals may also be used in the signa of a prescription to indicate the number of tablets to be taken as a single dose. In the prescription above, the Roman numeral ii in the signa indicates the number of tablets to be taken as a single dose.



c. In the above prescription, the Roman numeral IV following the symbol for a fluid ounce (f ℥) indicates that four fluid ounces of calamine lotion should be dispensed.

1-28. VALUES OF SINGLE NUMERALS

ss	or	$\overline{ss}$	= 1/2	L	or	l	= 50
I	or	i	= 1	C	or	c	= 100
V	or	v	= 5	D	or	d	= 500
X	or	x	= 10	M	or	m	= 1000

1-29. VALUES OF COMBINED NUMERALS

a. When a smaller valued or the same valued numeral follows another numeral, the numerals are to be added.

(1) II = 1 + 1 = 2

(2) VI = 5 + 1 = 6

(3) XXIII = 10 + 10 + 1 + 1 + 1 = 23

b. Convert the following Roman numerals to Arabic numbers:

(1) CCXXXII = _____

(2) XII = _____

(3) LVI = _____

c. Answers: (1) 232, (2) 12, (3) 56

d. When the numeral of a smaller value is placed in front of a numeral of larger value, the smaller value is to be subtracted from the larger value.

(1) IV = 5 - 1 = 4

(2) IX = 10 - 1 = 9

(3) VC = 100 - 5 = 95

* (4) LIV= 50 + 4 = 54

***NOTE:** In this case a smaller value I preceded a larger value V. Therefore, the smaller value had to be subtracted from the larger, making it four.

e. Convert the following Roman numerals to Arabic numbers:

(1) XL = _____ (5) XIV = _____

(2) XIX = _____ (6) XXXI = _____

(3) IVss = _____ (7) XLIII = _____

(4) XCIV = _____ (8) CIII = _____

f. Answers: (1) 40, (2) 19, (3) 4 1/2, (4) 94, (5) 14, (6) 39, (7) 43, (8) 103.

Section IV. RATIO AND PROPORTION

1- 30. INTRODUCTION

"Ratio and proportion" is discussed early in the course because most of the problems dealing with pharmaceutical calculations can be restated or can be broken down to a simple ratio and proportion problem. The principles discussed in this section will be of great value in solving most problems.

1-31. DEFINITIONS

a. Ratio: A ratio is the relationship of two quantities. A ratio may be expressed as a ratio (1:8, 1:200, etc.) or as a fraction (1/8, 1/200, and so forth.).

b. Proportion: A proportion is the equality of two ratios.

For example: $\frac{1}{2} = \frac{3}{6}$

c. A check as to the equality of two ratios can be made by cross multiplying. Multiply the numerator of the first ratio times the denominator of the second ratio. Then, multiply the denominator of the first ratio times the numerator of the second ratio. If the ratios are equal, the results of the cross multiplication will be the same.

For example:

$$\frac{1}{2} = \frac{3}{6}$$

$$1 \times 6 = 6$$

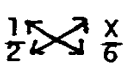
$$2 \times 3 = 6$$

$$6 = 6$$ Therefore, the ratios are equal.

d. The products of the cross multiplications are always equal in a proportion; if one factor of either ratio is unknown, it may be solved for by substituting X for the unknown factor in the proportion.

For example:

$$\frac{1}{2} = \frac{X}{6}$$



e. Cross multiply:

$$2(X) = 1(6)$$

$$2X = 6$$

$$\frac{2X}{2} = \frac{6}{2}$$

NOTE: If this operation is not understood, review para 1-20.

$$X = 3$$

1-32. CONDITIONS WHICH MUST BE MET

a. The numerators must have the same units.

b. The denominators must have the same units.

c. Three of the four variables must be known.

(1) In pharmacy, the EXPRESSION OF STRENGTH of the medication is usually the first ratio of the proportion and this ratio is put in proportion to the amount of medication to be made.

For example: If one aspirin tablet contains five grains of aspirin, then how many grains would be required to make 40 tablets?

(2) The EXPRESSION OF STRENGTH is "one tablet contains five grains of aspirin" and should be written as the first ratio of the proportion:

$$\text{IF } \frac{1 \text{ tablet}}{5 \text{ grains}} = \text{THEN } \_\_\_\_\_$$

(3) Next, assign X its proper place in the second proportion. Because the question asks, "How many grains?," the X is placed opposite the grains in the first proportion.

$$\text{IF } \frac{1 \text{ tablet}}{5 \text{ grains}} = \text{THEN } \frac{\_\_\_\_\_}{X \text{ grains}}$$

(4) In order for this to be a valid problem, the question has to tell how many tablets for which we are calculating. The question asks to calculate the number of grains in 40 tablets, therefore, the 40 tablets will be placed opposite the tablets in the first ratio.

$$\text{IF } \frac{1 \text{ tablet}}{5 \text{ grains}} = \text{THEN } \frac{40 \text{ tablets}}{X \text{ grains}}$$

(5) Prior to cross multiplying, make sure that corresponding units in each ratio are the same. Then, use the following steps

(a) Set up the proportion:

IF 1 tablet = THEN 40 tablets
5 grains X grains

(b) Cross multiply:

1 (X) = 5 (40)

1X = 200

(c) Solve for X: X = 200

(d) Refer back to step 1 to find the units of X. The units for X are grains. Therefore, the answer is 200 grains.

(6) The most common mistake people make is failing to label units. Labeling units will assure that corresponding units of the proportion are the same.

(7) Solve this problem:

How many milliliters of tetracycline suspension, which contains 250 mg of tetracycline in each five milliliters, must be administered to give a patient 150 mg?

(a) Find the EXPRESSION OF STRENGTH.

IF THEN

_____ = _____

(b) Assign the X value to its proper place in the second proportion:

IF THEN

_____ = _____

(c) Find the third known value:

IF THEN

_____ = _____

(8) Check to ensure corresponding units of the proportion are the same and then work the problem by the four-step method.

The proportion should be as follows:

$$\frac{250 \text{ mg}}{5 \text{ milliliters}} = \frac{150 \text{ mg}}{X \text{ milliliters}}$$

(9) Solve this proportion by using the four step method:

(a) Set up the proportion:

(b) Cross multiply:

(c) Solve for x:

(d) Refer back to step 1 to find the units for X:

(10) Solution:

(a) Set up formula:

$$\frac{250 \text{ mg}}{5 \text{ ml}} = \frac{150 \text{ mg}}{X \text{ ml}}$$

(b) Cross multiply:

$250 (X) = 5 (150)$

$250X = 750$

(c) Solve for X:

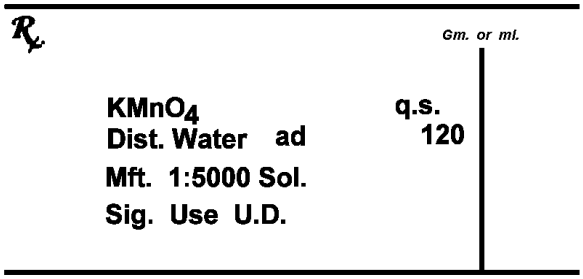
$$X = \frac{750}{250}$$

$X = 3$

(d) Refer to step 1 to find the units of X:

$X = 3$ ml

(11) Example problem: How many grams of potassium permanganate ($KMnO_4$) are needed to make this prescription?



(a) Before beginning the calculation, the prescription must be analyzed to see exactly what the physician wants. The prescription states that the pharmacist should dispense a solution of potassium permanganate in distilled water. The solution should have a strength equivalent to 1 gram per 5000 milliliters and the pharmacist should dispense 120 milliliters of the solution. The expression of strength will be the first ratio of the proportion:

$$\frac{1 \text{ gram}}{5000 \text{ ml}} = \_\_\_\_\_$$

(b) Assign the X value:

$$\frac{1 \text{ gram}}{5000 \text{ ml}} = \frac{X \text{ gram}}{\_\_}$$

(c) Find the other known factor:

$$\frac{1 \text{ gram}}{5000 \text{ ml}} = \frac{X \text{ gram}}{120 \text{ ml}}$$

(d) Then, cross-multiply:

$$5000\,(x) = 1\,(120)$$

$$5000\,x = 120$$

(e) Solve for X:

$$X = \frac{120}{5000}$$

$$X = 0.024$$

(f) Refer to the proportion for the units of X:

$$X = 0.024 \text{ gram}$$

d. Practical Exercises. Solve the following problems and check your answers.

(1) If 50 tablets contain 0.625 gram of an active ingredient, how many tablets can be prepared from 31.25 grams of the ingredient?

(2) If 50 tablets contain 1.5 gram of active ingredient, how much of the ingredient will 1375 tablets contain?

(3) If 3 doses of a liquid preparation contain 7.5 grains of a substance, how many doses will be needed to give a patient 80 grains of the substance?

(4) If 1.5 grams of a coloring agent are used to color 250 liters of a solution, how many liters could be colored by using 0.75 grams of the coloring agent?

(5) A solution contains 1/4 grain of morphine sulfate per 15 minims. How many minims will contain 1/6 grain of morphine sulfate?

(6) A vial of regular insulin contains 100 units per milliliter. How many milliliters should be given to a patient to obtain 18 units?

(7) Digoxin elixir contains 0.05 milligrams of digoxin per milliliter. How many milligrams will be contained in 3 milliliters of the elixir?

(8) A pharmacist prepared a suspension containing 5 million units of penicillin per 10 milliliters. How many units of penicillin will 1/4 milliliter of the suspension contain?

(9) Actifed Syrup is indicated for the symptomatic relief of upper respiratory congestion due to allergies. Each 5 milliliters of the yellow syrup contains:

Pseudoephedrine 30mg
Triprolidine 1.25mg

(a) If there are 473 milliliters in one pint, how many milligrams of triprolidine are in one pint of the Actifed Syrup?

(b) The manufacturer suggests a dosage regimen of 0.938 milligrams every 6 hours for children four to six years old. How many milliliters should a 5 year old child take as a single dose?

(c) How many milliliters of the syrup should be dispensed to this 5 year old patient if he is to take the medication for three weeks?

(10) To lower a patient's blood pressure, a physician has prescribed him 500 mg of methyldopa (Aldomet®) to be taken each day. Aldomet® is supplied as 250-mg tablets. If the patient takes this medication for 3 weeks, how many tablets will he take?

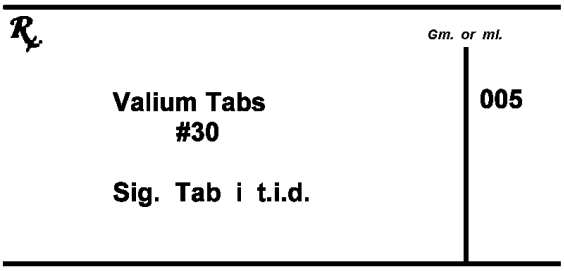
(11) A patient has been prescribed the anticancer drug Tamoxifen (Nolvadex®). The prescription has the following signa: Tabs p.o. i b.i.d. x 5 years. Each tablet contains 10 mg of tamoxifen. How many milligrams of Nolvadex® will the patient take in three weeks?

(12) A chronic alcoholic has been taking two 250-mg disulfiram (Antabuse®) tablets a day for 2 weeks, and then 1 tablet a day for the next 2 weeks. How many tablets did he take altogether?

(13) A person is taking three 100-mg capsules of diphenylhydantoin (Dilantin®) each day to reduce the chance of having an epileptic seizure. How many milligrams of Dilantin® would he take in 20 days?

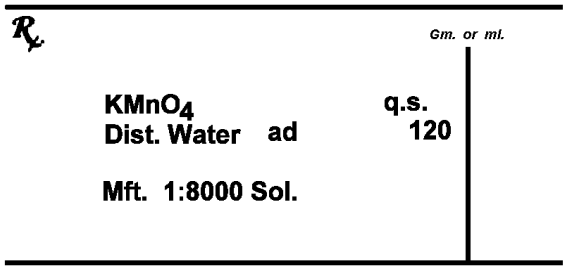
(14) The usual dose of dimenhydrinate (Dramamine®) is one 50-mg tablet every 4 hours to control motion sickness. COL Jones, who is presently flying from post to post on an inspection tour, has taken one tablet every 4 hours for the past two days. How many milligrams of Dramamine® has he taken?

(15)



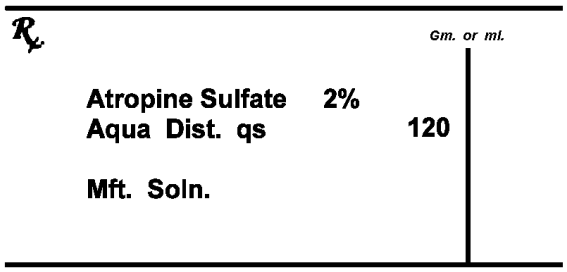
A patient received a prescription for diazepam (Valium®) as an anti-anxiety agent. If he takes the Valium® according to the prescription above, how many grams will he take in ten days?

(16)

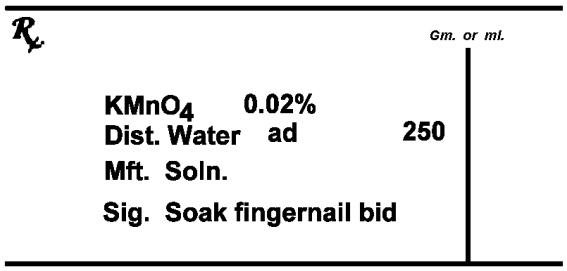


How many grams of potassium permanganate ($KMnO_4$) would be required to compound the prescription above?

(17) Percent means parts of 100. A 5% (W/V) solution contains 5 grams of active ingredient per 100 ml of total solution. With this in mind, calculate how many grams of atropine sulfate are needed to prepare the following prescription?

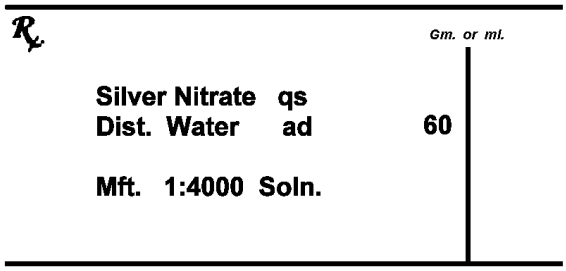


(18)



How many grams of potassium permanganate are needed to compound the prescription above?

(19) (a) How many grams of silver nitrate are needed to make the following prescription?



(b) How many milliliters of a 10% (W/V) silver nitrate solution would you use to get the desired amount?

e. Answers. Below are the answers to practical exercises (reference paragraph 1-32).

(1) 2500 tablets

(2) 41.25 gm

(3) 32 doses

(4) 125 liters

(5) 10 minims

(6) 0.18 ml

(7) 0.15 mg

(8) 125,000 units

(9) (a) 118.25 mg
(b) 3.75 ml (rounded from 3.752 ml)
(c) 315 ml (rounded from 315.168 ml)

(10) 42 tablets

(11) 420 mg

(12) 42 tablets

(13) 6000 mg

(14) 600 mg

(15) 0.15 grams

(16) 0.015 grams

(17) 2.4 grams

(18) 0.05 grams

(19) (a) 0.015 grams
(b) 0.15 ml

Section V. THE METRIC SYSTEM

1-33. INTRODUCTION

The most commonly used system of weights and measures in pharmacy is the metric system. The metric line on the prescription indicates the importance of this system. A thorough understanding of the metric system is needed to perform calculations in the pharmacy.

1-34. VALUES OF PREFIXES IN THE METRIC SYSTEM

a. The three basic units of the metric system are the meter, the gram, and the liter. The names of the other units are formed by adding a prefix to one of the basic units. Each prefix has a numerical value as indicated below:

PREFIX		VALUE
micro - (mc)	=	1/1,000,000
milli - (m)	=	1/1,000
centi - (c)	=	1/100 times the basic unit.
deci - (d)	=	1/10
deka - (dk)	=	10
hecto - (h)	=	100 times the basic unit.
Kilo - (k)	=	1000

b. Examples:

(1) 1 milliliter = 1/1000 X 1 liter or 0.001 liters.

(2) 1 microgram = 1/1,000,000 X 1 gram or 0.000001 grams.

(3) 1 dekameter = 10 X 1 meter or 10 meters.

1-35. BASIC UNITS OF THE METRIC SYSTEM

a. The Meter. The meter is the unit of length upon which the other units of the metric system are based.

(1) The meter is equal to 1/40,000,000 of the earth's polar circumference.

(2) One meter is equal to 39.37 inches.

(3) Abbreviation: m.

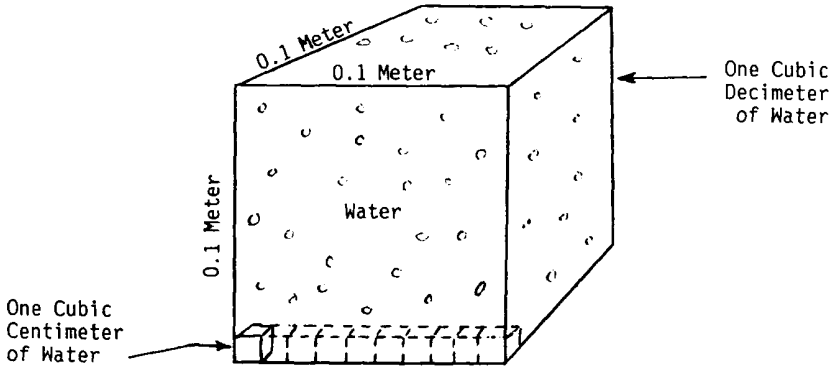
NOTE: The liter and the gram are the units of the metric system most used in the pharmacy. The meter is seldom used in the pharmacy.

b. The Liter. The liter is the basic unit of volume used to measure liquids in the pharmacy.

(1) One liter is equal to the volume of one cubic decimeter of water at 4°C. (see the diagram of the liter).

(2) Abbreviation: L or l.

The Liter



(3) There are 1000 cubic centimeters (cc's) of water in a liter. (See the diagram above.)

(4) 1/1000th of a liter is a milliliter.

(5) Therefore, 1 milliliter = 1 cubic centimeter

1 ml = 1 cc

(6) Common conversions:

(a) 1 liter = 1000 ml = 1000 cc

(b) 1 gallon = 3785 ml

(c) 1 quart = 946 ml

(d) 1 pint = 473 ml

(e) 1 fl oz = 30 ml (29.57)

NOTE: The liter has a slightly larger volume than the quart.

c. The Gram. The gram is the basic unit of weight used to weigh solids in the pharmacy.

(1) One gram is equal to the weight of one milliliter of distilled water at 4°C.

(2) Abbreviation: Gm or g

(3) Common conversions:

(a) 1 kg = 1000 g

(b) 1 g = 1000 mg

(c) 1 mg = 1000 mcg

(d) 1 lb. = 454 g

(e) 1 oz = 28.4 g (28.35)

1-36. USING CONVERSIONS IN PROBLEMS

a. The main reason to convert units is to satisfy unit equality in a ratio and proportion problem.

For example: If a syrup contains 250 milligrams of tetracycline in each 5 milliliters of the syrup, how many grams of tetracycline are needed to make four liters of the syrup?

b. When put in a proportion, the problem would be set up as follows:

$$\text{IF } \frac{250 \text{ mg}}{5 \text{ ml}} = \text{THEN } \frac{X \text{ grams}}{4 \text{ liters}}$$

c. Prior to cross-multiplying, the units must be the same:

Changes: 250 mg = 0.25 (g)

4 L = 4000 (ml)

d. Only when corresponding units are the same, may the cross-multiplication take place:

$$\frac{0.25 \text{ g}}{5 \text{ ml}} = \frac{X \text{ grams}}{4000 \text{ ml}}$$

Then: $5(X) = 0.25(4000)$
$5X = 1000$
$X = 200$ grams

1-37. CONVERSIONS WITHIN THE METRIC SYSTEM

a. To convert a quantity in the metric system to a larger denomination, move the decimal to the left.

Smaller to Larger (S L)
=
Right to Left (R L)

b. To convert to a smaller denomination, move the decimal point to the right.

Larger to Smaller (L S)
=
Left to Right (L R)

c. In each rule, the L's are together.

Example problems:

(1) 14 grams = _____ milligrams

(a) In changing from grams to milligrams, the change is from larger to a smaller denomination with the difference being a thousand between the units. Therefore, the rule will be:

Larger to Smaller L S
=
Left to Right L R

(b) Because there is a difference of 1000 between the units, the decimal must be moved three places to the right.

14 grams = 14,000 milligrams

(2) 50ml = _____ L

(a) In changing from milliliters to liters, the change is from a smaller to a larger denomination with a difference of a thousand between the units, therefore, the rule will be:

Smaller to Larger S L
=
Right to Left R L

(b) Because there is a difference of 1000 between the units, the decimal must be moved three places to the left.

50 ml = 0.05 liters

d. Solve the following:

(1) 4000 mg = _____g
(2) 0.04 kg = _____mg
(3) 3.47 L = _____ml
(4) 142 mcg = _____g
(5) 250mg = _____g
(6) 3L = _____ml
(7) 1,450 mg = _____kg
(8) 45kg = _____mg
(9) 0.25 g = _____mg
(10) 0.001 g = _____mg

Answers: (1) 4 g (2) 40,000 mg (3) 3,470 ml
(4) 0.000142 g (5) 0.25 g (6) 3,000 ml
(7) 0.00145 kg (8) 45,000,000 mg (9) 250 mg
(10) 1 mg

1-38. GENERAL RULES

a. To add and subtract, all quantities must be expressed in the same units.
For example: Add 30 mg, 2.5 kg, and 7.0 g. Express the answer in grams.

30 mg	=	0.030 g
2.5kg	=	2500.000 g
7 g	=	7.000 g
		2507.03 g (Answer)

b. When dividing or multiplying, units should be changed if necessary, but, general transfer and cancellation of units applies as in all mathematics.

For example: The strength of a drug is 5 mg per each milliliter of liquid. How many milliliters must be administered to give the patient 0.05 g of the drug?

$$\frac{5 \text{ mg}}{1 \text{ ml}} = \frac{0.05 \text{ g}}{X \text{ ml}}$$

NOTE: Because corresponding units of each ratio of the proportion must be the same, 0.05 g must be changed to milligrams.

The decimal must be moved three places to the right in changing from the larger unit, the gram, to the smaller unit, the milligram. 0.05 g = 50 mg. Then:

$$\frac{5 \text{ mg}}{1 \text{ ml}} = \frac{50 \text{ mg}}{X \text{ ml}}$$

$5X = 50$ milliliters

$X = 10$ milliliters

c. Practical Exercises. Work the following problems:

(1) Express the quantity 1.243 grams as:

(a) _____mg

(b) _____kg

(c) _____mcg

(2) Convert 8369 g to:

(a) _____mcg

(b) _____mg

(c) _____g

(d) _____kg

(3) Convert the volume 1.35 L to:

(a) _____ml

(b) _____cc

(4) Convert 2500 ml to:

(a) _____L

(b) _____kl

(5) What is the weight of 2.5 liters of distilled water? Express the answer in:

(a) _____g

(b) _____kg

(c) _____mg

(6) What quantity remains when:

(a) 260 cc's are removed from 2 L of alcohol? _____ml

(b) 450 mg are removed from 5 g of thiamine hydrochloride? _____g

(c) 18.7 g are removed from 2.5 kg of potassium hydroxide (K0H)?_____g

(d) 300 mg are removed from 1.6 g of potassium permanganate ($KMnO_4$)?_____mg

(7) 50 cc's of normal saline solution contain 450 mg of sodium chloride (NaC1). How many grams of NaCl would be needed to make two liters of the solution?

ANS:_____g

(8) 1500 tablets are made from 0.75 g of scopolamine hydrobromide. How many milligrams of scopolamine hydrobromide are contained in each tablet?

ANS: _____mg

(9) A USP unit of vitamin 0 is defined as the activity of 0.025 mcg of vitamin D. How many micrograms of vitamin D would be required to make a tablet that contains 500 USP units of vitamin 0?

ANS: _____mcg

(10) One unit of penicillin G Sodium is contained in 0.6 mcg of the penicillin.

(a) How many units will be in each milligram?

ANS: _____units

(b) What is the weight of 100,000 units in milligrams?

ANS: _____mg

(c) How many milligrams of the penicillin are needed to prepare 120 g of a penicillin ointment containing 1000 units per gram?

ANS: _____mg

(11) A vitamin B complex capsule contains:

In Each Capsule	To Make 5000 Capsules	
Vitamin B_1	1.5 mg	_____g
Vitamin B_2	1.0 mg	_____g
Vitamin B_6	200.0 mcg	_____g
Pantothenic Acid	1.0 mg	_____g
Nicotinamide	15.0 mg	_____g
Vitamin B_{12}	1.0 mcg	_____mg

Yeast concentrates and aromatics q.s.

How many grams of each ingredient in the above formula would be needed to make 5000 capsules? Place answers in the blanks.

(12) A 50,000 unit soluble tablet of penicillin is dissolved in distilled water. A total volume of 10 milliliters of penicillin solution is prepared. Then, 6 milliliters of the penicillin solution is incorporated into enough ointment base to make a total of 24 grams of penicillin ointment. The ointment should be labeled “Penicillin Ointment _____units per gram."

ANS: _____ units per gram

(13) The USP diagnostic dose of tuberculin P.P.D. is 0.00002 mg. Convert 0.00002 mg to micrograms.

ANS: _____ mcg

(14) The estimated minimum adult daily requirement of riboflavin is 2 mg. A capsule containing 1/4 the minimum requirement contains _____ mcg of riboflavin.

ANS: _____mcg

(15) Fifty-five milligrams of strychnine sulfate are divided into 45 doses. How many grams of strychnine sulfate are contained in each dose?

ANS: _____grams

(16) How many 2-mg doses of strychnine sulfate can be made from 0.1 g of the drug?

ANS: _____doses

(17) A stock solution contains 0.1 grams of atropine sulfate in 50 ml. How many milliliters of the solution would be needed to prepare a prescription requiring 4 mg of atropine sulfate.

ANS: _____ ml

(18)

℞	Gm or ml
Premarin Tablets #XL	0 | 00125
Sig: Tab i b.i.d.	

(a) How many milligrams of Premarin® are contained in each tablet?

ANS: _____mg

(b) How many grams are contained in the total prescription?

ANS: _____g

(19)

	Per Capsule	M.D.R.	To Make Per 100.000 Capsules
Vitamin A	1.25 X MDR	4,000 USP units	_____kg
Vitamin D	1.25 X MDR	400 USP units	_____kg
Ascorbic Acid	2 X MDR	30 mg	_____kg
Thiamine Mononitrate	3 X MDR	1 mg	_____g
Riboflavin		2 mg	_____g
Nicotinamide		20 mg	_____kg
Pantothenic Acid		5 mg	_____g
Pyridoxine HC1		300 mcg	_____g
Tocopherol		2 mg	_____ g

The vitamin A is supplied by oleovitamin A containing 50,000 units per gram. The vitamin D is supplied by synthetic oleovitamin D containing 10,000 units per gram. (MDR = Minimum Daily Requirement.) How much of each ingredient would be required to make the 100,000 capsules? Place answers in the blanks above.

(20) How many grams of aspirin would be needed to make 500 aspirin tablets if each tablet contains 325 mg of aspirin?

ANS: _____grams

d. Below are the answers to practical exercises (reference paragraphs 1-36 to 1-38).

(1) (a) 1,243 mg

(b) 0.001243 kg

(c) 1,243,000 mcg

(2) (a) 8,369,000,000 mcg

(b) 8,369,000 mg

(c) 8,369 g

(d) 8.369 kg

(3) (a) 1,350 ml

(b) 1,350 cc

(4) (a) 2.5 L

(b) 0.0025 kl

(5) (a) 2,500 g (Remember: 1.0 milliliter of distilled water weighs 1.0 gram at 4^{o}C.)

(b) 2.5 kg

(c) 2,500,000 mg

(6) (a) 1,740 ml

(b) 4.55 g

(c) 2,481.3 g

(d) 1,300 mg

(7) 18g

(8) 0.5 mg

(9) 12.5 mcg

(10) (a) 1667 units

(b) 60 mg

(c) 72 mg

(11) 7.5 g vitamin B_1

5.0 g vitamin B_2

1.0 g vitamin B_6

5.0 g Pantothenic acid

75.0 g Nicotinamide

5.0 mg vitamin B_{12}

(12) 1250 units per gram

(13) 0.02 mcg

(14) 500 mcg

(15) 0.0012 g

(16) 50 doses

(17) 2 ml

(18) (a) 1.25 mg

(b) 0.05 g

(19) 10.0 kg oleovitamin A

5.0 kg oleovitamin D

6.0 kg ascorbic acid

300 g thiamine Mononitrate

200 g riboflavin

2.0 kg Nicotinamide

500 g Pantothenic acid

30 g pyridoxine HC1

200 g Tocopherol

(20) 162.5 g

Section VI. COMMON SYSTEMS OF MEASURE

1-39. INTRODUCTION

a. There are two common systems of measure. They are the avoirdupois system, which we use in everyday life, and the apothecary system, which, as the name suggests is the one used by pharmacists and alchemists.

b. In the pharmacy, both systems have been replaced, for the most part, by the metric system. Prescriptions and drug orders could, however, have the weights or volumes expressed in units of one of the common systems. To facilitate the interpretation of these prescriptions, the relationships and conversion factors contained in this lesson must be committed to memory.

1-40. WEIGHT: AVOIRDUPOIS SYSTEM

a. Weight will almost always be expressed in the avoirdupois system when the common systems are used. The basic unit of weight in the avoirdupois system is the grain (gr). The larger units are the ounce (oz) and the pound (lb). You must know the following relationships between the avoirdupois units:

1 lb = 16 oz
1 oz = 437.5 gr

b. To convert from the avoirdupois system to the metric system, you must know these conversion factors:

1 gr = 65 mg

1 g = 15.4 gr

1 oz = 28.4 g

1 kg = 2.2 lb

1- 41. VOLUME: APOTHECARY SYSTEM

a. Volume will almost always be expressed in the apothecary system when the common systems are used. The units of volume in the apothecary system are the fluid dram (f$\mathfrak{Z}$), fluid ounce (f$\mathfrak{Z}$), pint (pt), quart (qt), and gallon (gal). Know the following relationships between apothecary units:

1 gal = 4 qt

1 gal = 128 f$\mathfrak{Z}$

1 qt = 2 pt

1 qt = 32 f$\mathfrak{Z}$

1 pt = 16 f$\mathfrak{Z}$

b. To convert from the apothecary system to the metric system, you must know the following factors:

1 gal = 3785 ml

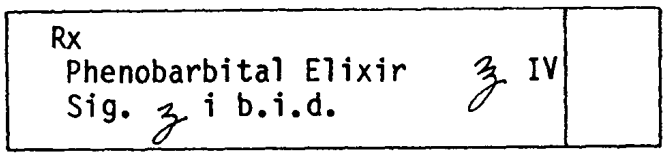
1 qt = 946 ml

1 pt = 473 ml

1 f$\mathfrak{Z}$ = 30 ml (29.57)

1 f$\mathfrak{Z}$ = 5 ml

NOTE: (1) When the sign appears in the signa of a prescription, it means a teaspoonful or 5 ml: $\mathfrak{Z}$i = 1 tsp = 5 ml (See the prescription below).



(2) When the doctor writes for $\mathfrak{Z}$ iv of a liquid preparation, it is taken to mean fluid $\mathfrak{Z}$ iv.

(3) To fill this prescription, dispense four fluid ounces (120 ml) of phenobarbital elixir and type: “Take one (1) teaspoonful two (2) times daily” as the directions to the patient.

(4) One tablespoonful = 15 ml = ℥ ss.

(5) When translating a signa, always use the smallest whole number of household equivalents possible without mixing teaspoonfuls and tablespoonfuls. This is done to decrease the possibility of error by the patient in measuring the proper dose.

c. The relationships and conversion factors contained in this lesson are not a complete description of the avoirdupois and apothecary systems, but are the ones you will need the most in the pharmacy. Further information may be found in Remington's Pharmaceutical Sciences and FM 8-260.

d. Practical Exercises.

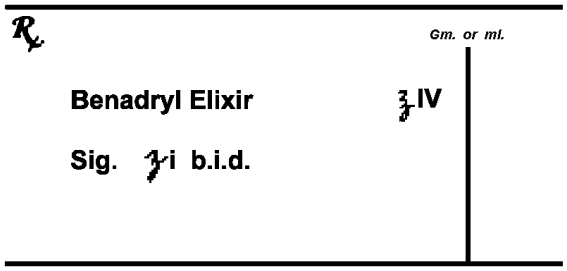
(1) Supply the appropriate equivalent as indicated:

(a) 16 f℥ = _____ pt = _____ gal = _____qt

(b) 6 pt = _____ qt = _____ f℥ = _____gal

(c)2 qt = _____ f℥ = _____ pt = _____gal

(2)



How many doses are contained in the above prescription?

ANS: _____doses

(3) How many f℥ iv bottles of Iodine Tincture USP, can be filled from one quart stock bottle?

ANS: _____bottles

(4) How many 5-gr capsules of aspirin can be made from 4 oz of aspirin?

ANS: _____ capsules

(5) How many 1/120-gr doses of atropine sulfate can be obtained from a l/8-oz stock bottle of atropine sulfate?

ANS: _____doses

(6) Supply the appropriate equivalent as indicated:

(a) f℥ iv = _____ ml

(b) 1/4 gr = _____ mg

(c) 5 gr = _____ g

(d) 7 1/2 gr = _____ g

(e) 1/65 gr = _____ mg

(f) 48 f℥ = _____ ml

(7) Supply the appropriate equivalents as indicated:

(a) 80 g =_____ oz

(b) 480 ml =_____ f℥

(c) 90 mg =_____ gr

(d) 20g =_____ gr

(e) 15 ml =_____ f℥

(f) 500 mg =_____ gr

(8) Supply the appropriate equivalent for each of the following:

(a) 10 ml =_____ tsp

(b) f℥ ss =_____ tbsp

(c) f℥ iv =_____ tsp

(d) 45 ml =_____ tbsp

(9) What size bottle, in f℥, must you dispense 240 ml of Ilosone® Liquid 250, Oral Suspension?

ANS: _____ f℥

(10) If a doctor prescribed "℥ i tid" of Maalox®, what amount would you tell the patient to take using household equivalents?

ANS: _____

(11) How many l/2-gr tablets can be made from 10 g of phenobarbital?

ANS:_____tablets

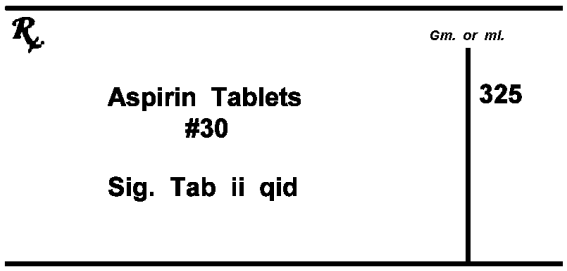
(12) If f℥ ii of Butisol® Elixir contain 2 gr of active ingredient, how many milligrams would there be in 15 ml?

ANS: _____mg

(13) If Silver Nitrate, USP, costs $2.09 per ounce, what is the cost of 4.8 g?

ANS: _____

(14) How many tablets would be needed to give the patient a l0 gr dose using the prescription below?



ANS: _____ tablets

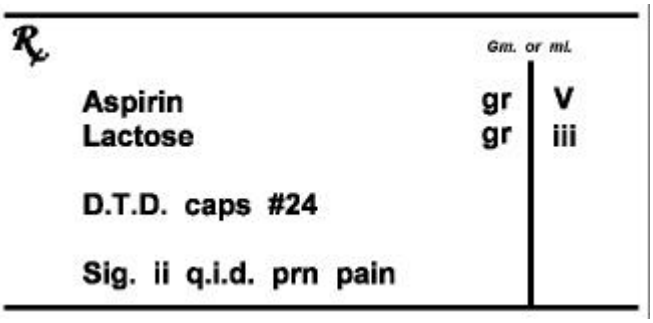
(15) What is the cost of 10 g of Bismuth Subcarbonate, USP, if 1 lb costs $8.56?

ANS:_____

(16) The usual dose of Antiminth® for the treatment of roundworms is 1 ml per 10 pounds of body weight? How many milliliters should be given to a child weighing 66 lbs.?

ANS: _____ mg

(17) How many grams of aspirin and how many grams of lactose are needed to make the following prescription?



(Remember: D.T.D. means that each capsule is to contain the specified amount of each substance.)

ANS:_____g aspirin

ANS:_____g lactose

(18) If you must add 25 ml of water to 75 g of wool fat to make lanolin, how many milliliters of water should be added to 1 lb. of wool fat to make lanolin?

ANS: _____ml

e. Below are the answers to practical exercises (reference paragraphs 1-40 to 1-41).

(1) (a) 1 pt = 1/8 gal = 1/2 qt

(b) 3 qt = 96 f$\overline{3}$ = 3/4 gal

(c) 64 f$\overline{3}$ = 4 pt = 1/2 gal

(2) 24 doses

(3) 8 bottles

(4) 350 capsules

(5) 6562 doses (**NOTE**: Each dose must be a whole dose.)

(6) (a) 120 ml

(b) 16.25 mg (16 mg)

(c) 0.325 g

(d) 0.487 g (0.5 g)

(e) 1 mg

(f) 1440 ml

(7) (a) 2.82 oz

(b) 16 f$\bar{3}$

(c) 1.38 gr

(d) 308 gr

(e) 1/2 f$\bar{3}$

(f) 7.69 gr (7.7 gr)

(8) (a) 2 tsp

(b) 1 tbsp

(c) 4 tsp

(d) 3 tbsp

(9) 8 f$\bar{3}$

(10) 2 Tbsp (6 tsp*) three times daily.

(11) 308 tablets (**NOTE**: Each tablet must contain 1/2 grain of drug.)

(12) 32.5 mg

(13) 35.3 cents

(14) 2 tablets

(15) 18.8 cents

(16) 6.6 ml

(17) 7.8 g aspirin

4.68g lactose

(18) 151 milliliters (or 151.47 ml)

*See paragraph 1-41b(7).

Section VII. REDUCTION AND ENLARGEMENT OF FORMULAS

1-42. INTRODUCTION

Most of the preparations made in a pharmacy are from proven formulas that have been tested and are listed in the United States Pharmacopeia/National Formulary (USP/NF) as official formulas. These formulas list the amount of each ingredient needed to make a certain amount of the preparation. At times, it is necessary to reduce or enlarge a formula to satisfy the needs of your pharmacy.

1-43. RATIO AND PROPORTION METHOD

a. The formula:

IF $\frac{\text{Amount of each ingredient in the official formula}}{\text{Total quantity of the official formula}}$ = THEN $\frac{\text{*Amount of each Ingredient needed}}{\text{Total quantity desired}}$

***NOTE**: Most of the time, the unknown factor will be the "Amount of each ingredient needed."

b. Sample Problem: Using the official formula below, calculate the amount of each ingredient needed to make 240 ml of Peppermint Spirit.

Peppermint Spirit

Peppermint Oil..... 100 ml

Peppermint Powder.....10 g

Alcohol.....qsad..... 1000 ml

(1) Solve first for the amount of peppermint oil needed:

IF THEN

$$\frac{\text{100 ml Peppermint oil}}{\text{1000 ml spirit}} = \frac{\text{X ml peppermint oil}}{\text{240 ml spirit}}$$

(2) Cross multiply: (1000) X = 100 (240)

1000 X = 24000

X = 24 ml of peppermint oil

(3) To solve for the amount of peppermint powder needed:

IF THEN

$$\frac{\text{10 g peppermint powder}}{\text{1000 ml of spirit}} = \frac{\text{X g peppermint powder}}{\text{240 ml of spirit}}$$

(4) Cross multiply: (1000)X = 10 (240)

1000 X = 2400

X = 2.4 g of Peppermint powder

c. Knowing that gsad means to "add a sufficient quantity up to," take 2.4 g of peppermint powder, add 24 ml of peppermint oil, and add as much alcohol as is necessary to make 240 milliliters. The final product will be Peppermint Spirit.

1-44. CONVERSION FACTOR METHOD

The conversion factor method is the easiest and therefore the most widely used method for reducing or enlarging formulas.

a. Find the conversion factor:

$$\frac{\text{Total quantity desired}}{\text{Total quantity of official formula}} = \text{Conversion Factor}$$

NOTE: The "Total Quantity Desired" and the "Total Quantity of Official Formula" must have the same units so the units will cancel and yield a conversion factor without units.

b. Use conversion factor in formula:

Conversion factor	X	amount of ingredient in official formula	=	amount of each ingredient needed

c. Sample Problem: Use the official formula below to calculate how much of each ingredient would be needed to make 120 ml of Cocoa Syrup.

Cocoa Syrup

Cocoa…….		180 g
Sucrose…….		600 g
Liquid glucose…….		180 ml
Glycerin…….		50 ml
Sodium chloride…….		2 g
Vanillin…….		0.2 g
Sodium benzoate…….		1 g
Pure water …….	qsad ……	1000 ml

(1) The first step is to find the conversion factor:

$$\frac{120 \text{ ml}}{1{,}000 \text{ ml}} = \text{conversion factor}$$

NOTE: The units, by being the same, cancel.

0.12 = conversion factor

(2) The second step is to multiply the conversion factor times the amount of each ingredient in the original formula:

Conversion Factor	X	Amount of Ingredient in Official Formula	=	Amount of Each Ingredient Needed
0.12	X	180 g	=	21.6 g of cocoa
0.12	X	600 g	=	72.0 g of sucrose
0.12	X	180 g	=	21.6 g of liquid glucose
0.12	X	50 ml	=	6.0 ml of glycerin
0.12	X	2 g	=	0.24 g of NaCl
0.12	X	0.2 g	=	0.024 g of vanillin

0.12	X	1.0 g	=	0.12 g of sodium benzoate
0.12	X	qs 1,000 ml	=	120 ml with pure water

NOTE: The units for each answer are the same as the units in the original formula for that ingredient.

d. The thing to be remembered is that in finding a conversion factor, the amount desired always is on top and the amount of the formula is always on the bottom.

e. Work the following problems and check the answers.

(1) Use the official formula below to calculate the amount of each ingredient that should be used to make 90 ml of Orange Syrup.

Orange Syrup

Sweet orange peel tincture....	50 ml	_____	ml
Citric acid.....	5 g	_____	g
Talc.....	1 5 g	_____	g
Sucrose.....	820 g	_____	g
Pure water.....qsad.....	1000 ml	qsad 90	ml

(2) Use the formula listed below to calculate how much of each ingredient should be used to make 20,000 ml of Chigger Dope that is used to treat chigger insect bites.

Chigger Dope

Benzocaine……	400 g	_____	g
Methyl salicylate……	160 ml	_____	ml
Salicylic acid…….	40 g	_____	g
Isopropyl Alcohol NF, 99%	5,840 ml	_____	ml
Pure water... qsad …….	8,000 ml	qsad _____	ml

(3) Use the formula listed below to calculate the amount of each ingredient that should be used to make one pound of baby powder.

Baby Powder

Boric acid……	30 g	_____g
Zinc stearate……	20 g	_____g
Talc……	50 g	_____g

NOTE: Be careful because the total quantity is not given in this formula; therefore, you must find the total by adding the ingredients.

(4) Use the formula listed below to calculate the amount of each ingredient that should be used to make 120 ml of Phenolated Calamine Lotion.

Phenolated Calamine Lotion

Calamine lotion……	990 ml	_____ml
Liquid phenol……	10 ml	_____ml

(5) Use the formula listed below to calculate the amount of each ingredient that should be used to make 60 g of compound senna powder.

Compound Senna Powder

Senna……	180 g	_____g
Glycyrrhiza……	236 g	_____ g
Washed sulfur……	80 g	_____g
Fennel oil……	4 g	_____ g
Sucrose……	500 g	_____g

(6) Use the formula listed below to calculate the amount of each ingredient that should be used to make 180 ml of cherry syrup.

Cherry Syrup

Cherry juice…… 475 ml _____ml

Sucrose…….. 800 g _____g

Alcohol…….. 20 ml _____ml

Pure water...qsad……1,000 ml _____ml

(7) Use the formula listed below to calculate the amount of each ingredient that should be used to make 10 ounces of pine tar ointment.

Pine Tar Ointment

Yellow wax……150 g_____g

Yellow ointment……350 g_____g

Pine tar…….. 500 g_____g

(8) Using the formula below, calculate the amount of each ingredient that should be used to make one gallon of calamine lotion.

Calamine…….. 8 g_____g

Zinc oxide…….. 8 g_____g

Glycerin…….. 2 ml_____ml

Avicel R Gel…….. 2 g_____g

Carboxymethylcellulose…….. 2 g_____g

Calcium hydroxide soln……qs…100 ml qs _____ml

f. Below are the answers to practical problems (reference paragraphs 1-43 to 1-44).

(1)
4.50 ml
0.45 g
1.35 g
73.80 g

(2)
1,000 g
400 ml
100 g
14,600 ml
20,000 ml

(3)
136.2 g
90.8 g
227.0 g

(4)
118.8 ml
1.2 ml

(5)
10.80 g
14.16 g
4.80 g
0.24 g
30.00 g

(6)
85.5 ml
144.0 g
3.6 ml
180.0 ml

(7)
42.6 g
99.4 g
142.0 g

(8)
302.8 g calamine
302.8 g zinc oxide
75.7 ml glycerin
75.7 g Avicel R Gel
75.7 ml Carboxymethylcellulose
qs 3785 ml Calcium hydroxide Solution

Continue with Exercises ***Return to Table of Contents***

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. U-100 Insulin contains 100 units of Insulin in each milliliter of suspension. How many milliliters of the suspension must be administered to give the patient 60 units?

ANS: _____ml

2. Fill in the blanks:

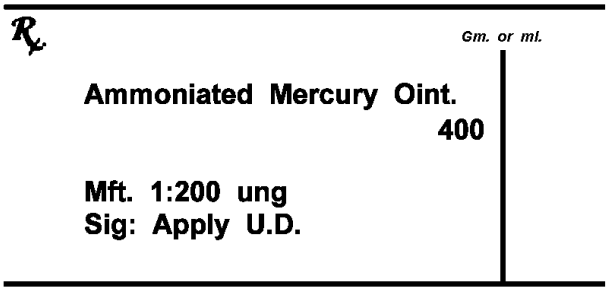
a.	6.5 g	=____mcg	e.	16.5 kg	=_____mg
b.	0.250mg	=_____g	f.	16.5 mg	=_____g
c.	1.45 L	=_____ml	g.	0.010 g	=_____mg
d.	0.15 ml	=_____L	h.	0.03 mg	=_____mcg

3. Formula for Glycerogelatin.

Glycerinated gelatin…….	300 g_____ g
Glycerin……	250 g_____ g
Distilled water……	350 ml_____ ml
Medicinal substance, in fine powder	100 g_____ g
To make……	1000 g _____g

How much of each ingredient would be required to make one pound of this formula? Place the answers in the blanks above.

4. How many grams of ammoniated mercury would be needed to compound this prescription?



ANS: _____grams

5. Convert 104°C to °F:

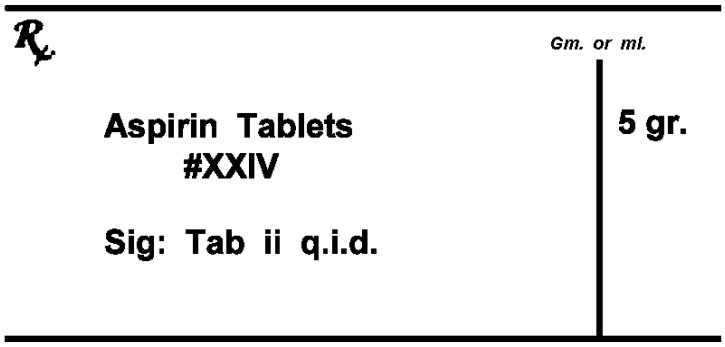
Formula: 5F = 9C + 160

ANS: _____°F

6. Tetracycline suspension contains 250 mg of tetracycline per each five cc's. How much of the suspension would be required to give a patient 125 mg of tetracycline? Give the answer in household equivalents.

ANS: _____

7. The questions in this exercise refer to the prescription below.



(a) How many milligrams of aspirin are contained in each tablet?

ANS: _____milligrams

(b) How many grams of aspirin are contained in the total prescription?

ANS: _____grams

(c) How many days will the prescription last if taken as directed?

ANS: _____days

8. Pyrantel pamoate (Antiminth®) is given as treatment for roundworms in a single dose of 1 ml for 10 pounds of body weight. What would be the dose in milliliters for a 44-lb child?

ANS: _____ml

9. Meperidine hydrochloride (Demerol®) injection contains 50 milligrams of meperidine HCl per each milliliter of injection. How many milliliters must be administered to give a patient 80 milligrams of the drug?

ANS: _____ml

10. Fill in the blanks:

a. gr i = _____mg

b. 1 gal = _____ml

c. 1 oz = _____g

d. ℥ i = _____tsp

e. 1 kg = _____lbs

f. 1 pt = _____ml

g. i ℥ = _____ml

h. 1 lb = _____g

i. 1 qt = _____ml

j. 1 oz = _____gr

k. ℥ i = _____Tbsp

l. 1 g = _____gr

m. 1 tsp = _____ml

11. Perform the indicated operations:

a. 1/2 + 3/4 =_____

b. 3/16 ÷ 1/4 =_____

c. 1000 x 0.04 =_____

d. 5/8 x 1/4 =_____

e. 6/7 - 5/6 =_____

f. 1.65 ÷ 0.45 =_____

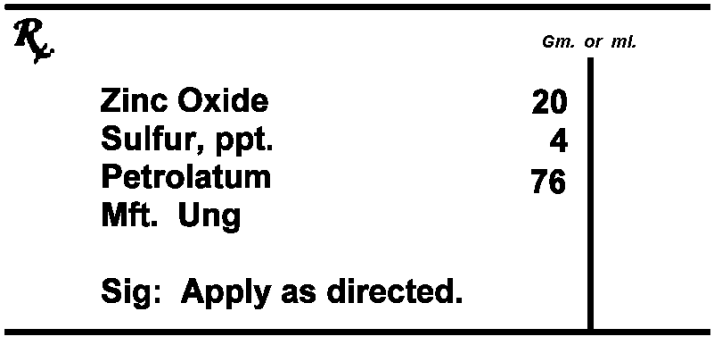
g. 4.74 x 6.2 =_____

h. 454 ÷ 0.325 =_____

12. Calculate the number of 1/2-grain phenobarbital capsules that can be made from 4 ounces of phenobarbital.

ANS:_____capsules

13. How many grams of each ingredient would be required to make two kilograms of this preparation?



℞

	Gm. or ml.
Zinc Oxide	20
Sulfur, ppt.	4
Petrolatum	76
Mft. Ung	
Sig: Apply as directed.	

ANS: _____g zinc oxide
_____g sulfur
_____g petrolatum

14. To lower a patient's elevated blood pressure, a physician has prescribed 500 mg of methyldopa (Aldomet®) to be taken each day. Aldomet® is supplied in 250-mg tablets. How many tablets must be dispensed to give the patient a 30-day regimen?

ANS:_____tablets

15. How many 30-mg doses can be made from one ounce of a drug?

ANS: _____ doses

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. 0.6 ml (para 1-32)

2. a. 6,500,000 mcg (para 1-35)
   b. 0.00025 g
   c. 1450 ml
   d. 0.00015 L
   e. 16,500,000 mg
   f. 0.0165 g
   g. 10 mg
   h. 30 mcg

3. 136.2 g glycerinated gelatin (para 1-40)
   113.5 g glycerin
   158.9 ml distilled water
   45.4 g medicinal substance
   454.0 g total preparation

4. 2 grams (para 1-26)

5. 219.2^{o} F (para 1-23)

6. 1/2 teaspoonful (para 1-32)

7. a. 325 mg (para 1-27)
   b. 7.8 g
   c. 3 days

8. 4.4 ml (para 1-32)

9. 1.6 ml (para 1-32)

10. a. 65 mg (para 1-35)
    b. 3785 ml
    c. 28.4 g
    d. 1 tsp
    e. 2.2 lbs
    f. 473 ml
    g. 30 ml
    h. 454 g
    i. 946 ml
    j. 437.5 gr
    k. 2 tbsp
    l. 15.4 gr
    m. 5 ml

11. a. 1 1/4 (para 1-8)

    b. 3/4 (para 1-11)

    c. 40 (para 1-18)

    d. 5/32 (para 1-10)

    e. 1/42 (para 1-9)

    f. 3.67 (para 1-19)

    g. 29.388 (para 1-18)

    h. 1396.923 (para 1-19)

12. 3500 capsules (para 1-32)

13. 400 g zinc oxide (para 1-44)
    80 g sulfur, ppt
    1520 g petrolatum

14. 60 tablets (para 1-32)

15. 946 doses (Remember: Each dose must be a whole dose.) (para 1-40)

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LESSON ASSIGNMENT

LESSON 2	Pharmaceutical Calculations II.
TEXT ASSIGNMENT	Paragraphs 2-1 through 2-14.
LESSON OBJECTIVES	After completing this lesson, you should be able to: 2-1. Solve pharmaceutical problems involving specific gravity. 2-2. Solve pharmaceutical calculation problems involving percentage strengths and ratio strengths. 2-3. Calculate the amount of a higher strength stock preparation required to prepare a specified amount of a lesser strength product. 2-4. Calculate the amount of diluent to be combined with a given amount of stock preparation to make a product of a lesser strength. 2-5. Calculate the amounts of two stock preparations required to prepare a specified volume of a stated intermediate strength preparation when given the strengths of the two stock preparations.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

PHARMACEUTICAL CALCULATIONS II

Section I. SPECIFIC GRAVITY

2-1. INTRODUCTION

Specific gravity often becomes a part of the solution to a pharmaceutical calculation. Hence, the main use of specific gravity is to solve for a liquid's volume when the weight of the liquid is known. Because of the difficulty which may be encountered in trying to weigh a liquid, it is often advantageous to calculate the liquid's volume and measure it in a graduate as opposed to weighing it.

2-2. DEFINITION

a. Specific Gravity. Specific gravity is the ratio of the weight of a substance to the weight of an equal volume of distilled water at 25ºC.

b. At 25ºC and 1 atmosphere of pressure, one milliliter of distilled water weighs one gram. Therefore, the specific gravity of water is established as one.

c. Formula.

$$\text{Specific gravity} = \frac{\text{Weight of the substance}}{\text{Weight of an equal volume of water}}$$

d. Because one milliliter of water weighs one gram:

$$\text{Specific gravity} = \frac{\text{Number of grams of the substance}}{\text{Number of milliliters of the substance}}$$

e. Specific gravity has no units. Because specific gravity has no units, only the numbers must be placed in the formula providing the units of weight and volume are grams and milliliters. If units are other than grams and milliliters, using the conversion factors as discussed in the metric system and common systems of measure should change them.

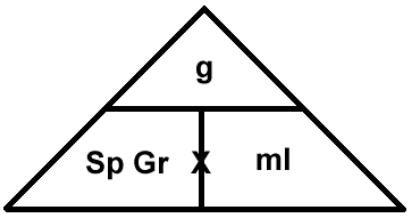
f. Example Problem. What is the specific gravity of 10 milliliters of mineral oil, which weighs 8.5 grams?

$$\text{Specific gravity} = \frac{\text{\# of grams of substance}}{\text{\# of milliliters of the substance}}$$

$$\text{Specific gravity} = \frac{8.5}{10} \qquad \text{Sp gr} = 0.85$$

2-3. SPECIFIC GRAVITY TRIANGLE

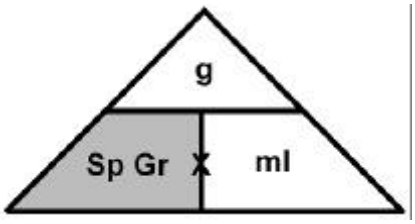
a. The triangle below is an excellent aid in the solving of specific gravity problems.



b. To use the triangle, cover the unit for which you are solving; then, perform the operation indicated.

c. For example: What is the specific gravity of an alcohol that has a volume of 1000 milliliters and weighs 810 grams?

Cover specific gravity:



d. Perform the operation that is left: $\frac{\text{grams}}{\text{milliliters}}$

$$\text{Sp gr} = \frac{\text{grams}}{\text{milliliters}}$$

$$\text{Sp gr} = \frac{810}{1000}$$

$$\text{Sp gr} = 0.810$$

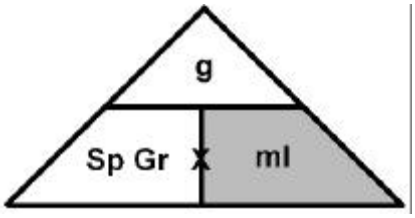
e. Example problem.

Water Soluble Ointment Base

Calcium citrate…….	0.05 g
Sodium alginate…….	3.00 g
Methylparaben……	0.20 g
Glycerin……	45.00 g
Distilled Water……To make……	1000.00 ml

(1) In this formula, the amount of glycerin is given as grams, a measure of weight. Because glycerin is a liquid, it would be easier to change the grams to milliliters and measure the glycerin in a graduate. The specific gravity of glycerin is 1.25. How many milliliters of glycerin would be required?

(2) Using the triangle:



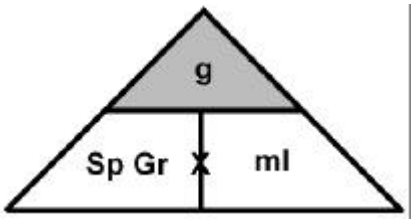
Therefore: milliliters = $\frac{\text{grams}}{\text{specific gravity}}$

milliliters = $\frac{45}{1.25}$

milliliters = 36 (answer)

(3) In the place of weighing 45 grams of glycerin, 36 milliliters of glycerin may be measured.

f. Example problem. What is the weight in grams of 240 milliliters of light liquid petrolatum having a specific gravity of 0.81?



g = sp gr X ml

g = 0.81 x 240

g = 194.4 (answer)

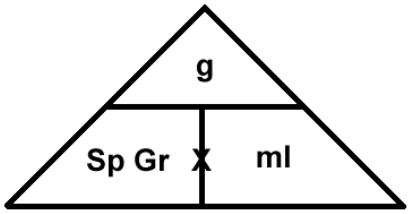
240 milliliters of light liquid petrolatum weighs 194.4 grams.

g. Example problem. The following prescription has all of the amounts indicated as grams with the exception of mineral oil. Because mineral oil is a liquid, the units, as written on this prescription, are milliliters. In compounding this prescription, all of the substances must be weighed or measured separately and then combined by a certain procedure. It is impractical to "q.s." with an ointment base. Instead, the weights of all the other ingredients must be totaled and this combined weight must be subtracted from the total amount of the preparation to find the amount of white petrolatum needed. To accomplish this, the weight of the 8 milliliters of mineral oil must be calculated. Specific gravity of mineral oil = 0.85.

℞

	Gm. or ml.	
Zinc Oxide	14	0
Sulfur, ppt.	4	0
Mineral Oil	8	0
White Petrolatum qs	100	0

Sig: Apply U.D.



(1) grams = specific gravity x milliliters

grams = .85 x 8

grams = 6.8

(2) Then, add the weights of all ingredients except the white petrolatum.

14.0 g zinc oxide
+4.0 g sulfur, ppt
6.8 g mineral oil
24.8 g

(3) Subtract this from the total volume.

100.0 g total volume
-24.8 g other substances
75.2 g white petrolatum required

(4) The above problem is a typical pharmaceutical calculation problem involving specific gravity.

h. Solve the following problems and check your answers.

(1) What is the volume of 250 g of a liquid having a specific gravity of 1.65?

Ans: _____ ml

(2) What is the weight of 350 milliliters of syrup having a specific gravity of 1.313?

As: _____ grams

(3) What is the weight, in grams, of five milliliters of concentrated nitric acid? (See Specific Gravity Table on page 2-9 of this subcourse.)

Ans: _____ grams

(4) What is the weight, in pounds, of one pint of carbon tetra-chloride?

Ans: _____ lbs

(5) Because his patient is allergic to mineral oil, a physician has asked you to substitute an equal weight of olive oil for the 10 ml of mineral oil he has in a lotion. How many milliliters of olive oil would be needed?

Ans: _____ ml

(6) Rx

Tannic Acid	20.0 g
Exsicc. Sodium Sulfite	0.2 g
Glycerin	25.0 g
Yellow Ointment	54.8 g
	100.0 g

How many milliliters of glycerin must be used to make 100 grams of the above preparation?

Ans: _____ ml

(7) The official formula for Boric Acid Ointment NF XI is as follows:

Boric acid powder	100.0 g
Liquid petrolatum	50.0 g
White ointment	850.0 g

How many milliliters of liquid petrolatum, light, would be needed to make 120 g of this boric acid ointment?

Ans: _____ ml

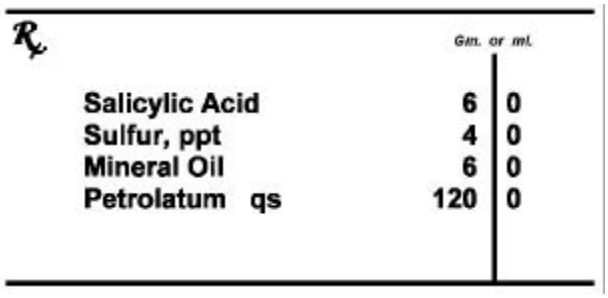
(8) One formula for an O/W ointment base is as follows:

Calcium citrate	0.05 g
Sodium alginate	3.00 g
Methylparaben	0.20 g
Glycerin	45.00 g
Distilled water qs.ad	1000.00 g

How many milliliters of glycerin would be needed to prepare 500 g of the above ointment base?

Ans: _____ ml

(9) How many grams of petrolatum would be required to make this prescription?



Ans: _____ grams

(10) What is the specific gravity of a solution having a volume of 473 milliliters and weighing 500 grams?

Ans: _____ specific gravity

Acetic Acid, 36.5% W/W	1.05
Acetic Acid, Diluted, 6% W/V	1.01
Acetic Acid, Glacial	1.05
Acetone	0.79
Alcohol, 95% V/V at 15.56ºC	0.816
Alcohol, Absolute, at 5.56ºC	0.798
Ammonia Solution, Diluted, 9.5% W/V	0.96
Ammonia Solution, Strong, 28.5% W/W	0.9
Anethol	0.99
Anise Oil	0.98
Bay Oil	0.97
Benzyl Benzoate	1.12
Cade Oil	1.0
Carbon Disulfide	1.26
Carbon Tetrachloride	1.59
Chloroform	1.48
Clove Oil	1.05
Cottonseed	0.92
Ether, Solvent	0.71
Ethyl Acetate	0.9
Ethyl Oxide	0.71
Eucalyptol	0.92
Eugenol	1.07

Table 2-1: Specific gravity of liquids at 25°C. (Continued)

Glycerin	1.25
Hydrochloric Acid, 36.5% W/W	1.18
Hydrochloric Acid, Diluted, 10% W/V	1.05
Isopropyl Alcohol	0.78
Lactic Acid, 87.5% W/W	1.21
Lemon Oil	0.85
Liquid Petrolatum, Light	0.81
Methyl Salicylate	1.18
Mineral Oil	0.85
Nitric Acid, Conc., 69% W/W	1.41
Oleic Acid	0.9
Olive Oil	0.91
Peppermint Oil	0.90
Phosphoric Acid, 86.5% W/W	1.71
Phosphoric Acid, Diluted, 10% W/V	1.06
Potassium Iodide Solution, Saturated	1.7
Sulfuric Acid, Conc., 96% W/W	1.84
Sulfuric Acid, Diluted, 10% W/V	1.07
Tar Oil	0.97
Turpentine Oil	0.86
Water, Distilled	1.00
Wintergreen Oil	1.18
Zinc Chloride Solution, 50% W/W	1.55

Table 2-1: Specific gravity of liquids at 25°C. (Concluded)

i. Below are the answers to problems (reference paragraphs 2-2 to 2-3).

(1) 250 ÷ (1.65) = 151.51515 (rounded to 151.52 ml)

(2) 350 (1.313) = 459.55 g

(3) 5 (1.41) = 7.05 g

(4) 473 (1.59) = 752.07 g

Then: 752.07g ÷ 454 g/lb = 1.6565418 (rounded to 1.66 lb)

(5) 10 X 0.85 = 8.5 g mineral oil

Then $\frac{8.5}{0.91}$ = 9.3406593 (rounded to 9.34 ml olive oil)

(6) 25.0 ÷ 1.25 = 20.0 ml

(7) 6 ÷ 0.81 = 7.4074074 (rounded to 7.41 ml)

(8) Reduce formula: 45 gm ÷ 2 = 22.5 g glycerin needed

Then: 22.5 ÷ 1.25 = 18.0 ml

(9) 6 (0.85) = 5.1 g mineral oil

Then: Add all other ingredients

6.0 g sal acid
4.0 g sulfur, ppt
5.1 g mineral oil
15.1 g other ingredients

Then: 120.0 g total weight
-15.1 g other ingredients
104.9 g petrolatum needed (answer)

(10) 500 ÷ 473 = 1.0570824 (rounded to 1.06 specific gravity)

Section II. PERCENTAGE PREPARATIONS

2-4. INTRODUCTION

Many of the prescriptions received in the pharmacy have the amounts of active ingredients expressed as percentage strengths as opposed to a weight or volume which can be measured. The physician knows that each active ingredient, when given in a certain percentage strength, gives the desired therapeutic effect. Instead of the physician calculating the amount of each ingredient needed for the prescription, he will simply indicate the percentage strength desired for each ingredient and expect the pharmacy to calculate the amount of each ingredient based on its percentage strength. There are no percentage weights for a torsion balance or percentage graduations on a graduate. The percentage values on a prescription must be changed to amounts which can be weighed (grams) or to amounts which can be measured (milliliters).

2-5. TYPES OF PERCENT

Recall that the term percent means "parts per hundred" and is expressed in the following manner:

$$\frac{\text{\# OF PARTS}}{\text{100 PARTS}}$$

a. W/W percent or Weight/Weight percent is defined as the number of grams in 100 grams of a solid preparation.

(1) Example #1 A 5 percent (w/w) boric acid ointment would contain 5 grams of boric acid in each 100 grams of boric acid ointment.

(2) Example #2:A 3 percent (w/w) vioform powder would contain 3grams of vioform in every 100 grams of the vioform powder.

b. W/V of Weight/Volume percent is defined as the number of grams in 100 milliliters of solution.

(1) Example #1:A 10 percent (w/v) potassium chloride (KCL) elixir would contain 10 grams of potassium chloride in every 100 milliliters of KC1 elixir.

(2) Example #2:A 1/2 percent (w/v) phenobarbital elixir would contain 1/2 gram of phenobarbital in every 100 milliliters of phenobarbital elixir.

c. V/V percent or Volume/Volume percent is defined as the number of milliliters in every 100 ml of solution.

(1) Example #1:A 70% (v/v) alcoholic solution would contain 70 milliliters of alcohol in every 100 ml of solution.

(2) Example #2:A 0.5% (v/v) glacial acetic acid solution would contain 0.5 milliliters of glacial acetic acid in each 100 milliliters of solution.

d. When the type of percent is not stated, it is understood that dilutions of (1) dry ingredient in a dry preparation are percent W/W, (2) dry ingredients in a liquid are percent W/V, and (3) a liquid in a liquid is percent V/V.

2-6. METHODS FOR SOLVING PERCENTAGE PROBLEMS

a. Ratio and proportion:

Formula:

$$\text{IF } \frac{\text{\# of parts}}{100} = \text{THEN } \frac{\text{Amount of solute needed}}{\text{Total volume or weight of product}}$$

b. **Sample** problems:

(1) Example #1:How many grams of zinc oxide are needed to make 240 grams of a 4% (w/w) zinc oxide ointment?

$$\text{IF } \frac{\text{4 g ZnO}}{\text{100 g Oint}} = \text{THEN } \frac{\text{X g ZnO}}{\text{240 g Oint}}$$

NOTE: Because all the units involved in this problem are the same (grams), each unit is labeled as to what it represents. In the first ratio, the desired strength of the ointment is indicated. A four percent zinc oxide ointment contains 4 grams of zinc oxide in each 100 grams of ointment and is labeled to indicate this. Because the question asks, "how many grams of zinc oxide?," the X value must be placed opposite the grams of zinc oxide in the first ratio (see above). The 240 grams of ointment is placed opposite the grams of ointment in the first ratio.

Then: $100\,X = 960$

$X = 9.6$ g of zinc oxide

(2) Example #2: How many milliliters of a 5% (w/v) boric acid solution can be made from 20 grams of boric acid?

IF THEN

$$\frac{5\text{ g}}{100\text{ ml}} = \frac{20\text{ g}}{X\text{ ml}}$$

$$5X = 2000$$

$$X = 400$$

(3) Example #3: How many milliliters of paraldehyde are needed to make 120 ml of a 10% (v/v) paraldehyde solution?

IF THEN

_____ = _____

Answer: 12 ml of paraldehyde

NOTE: Because all of the units involved in this problem are the same (ml), they must be labeled as to what they represent. A 10% paraldehyde solution contains 10 milliliters of paraldehyde in each 100 ml of solution and the first ratio of the proportion should indicate this (see below). The question asks, "How many milliliters of paraldehyde are needed?" therefore, the X value must be placed in the proportion opposite the 10 ml of paraldehyde in the first ratio. The 120 ml represents final solution.

IF $\frac{\text{10 ml paraldehyde}}{\text{100 ml of solution}} = \text{THEN} \frac{\text{X ml paraldehyde}}{\text{120 ml of solution}}$

100 X = 1200

X = 12 ml of paraldehyde

c. One percent Method: The 1 percent Method is used only to find the amount of active ingredient when the final volume or weight of the preparation is known. This method cannot be used to calculate the amount of preparation that can be made when the percentage strength and the amount of active ingredient is known.

1 percent Method:

Formula:

(1 percent of the total amount of preparation) X (number of percent) = The amount of active ingredient)

NOTE: 1 percent of the total amount of preparation can be found by moving the decimal point on the total amount of preparation two places to the left.

Sample Problems:

(1) Example #1: How many grams of ephedrine sulfate are needed to make 120 ml of a 2% (w/v) ephedrine sulfate solution?

(a) Find the total amount of preparation:

The total amount is 120 ml

(b) Find 1 percent of the total amount:

1 percent of 120 = 1.2

(c) One percent of volume times the number of percent = Amount of active ingredient.

1.2 X 2 = 2.4 grams of ephedrine sulfate needed.

NOTE: When calculating percentage problems in the metric system, the unit designation is dependent upon whether the active ingredient is a solid or a liquid. Because ephedrine sulfate is a solid, the unit designation is grams.

(2) Example #2: How many grams of boric acid are needed to make 240 ml of a 5% (w/v) boric acid solution?

(a) The total amount of preparation is 240 ml.

(b) 1 percent of 240 = 2.4

(c) 2.4 X 5 = 12 grams of boric acid required.

(3) Example #3: How many grams of zinc oxide are needed to make 120 grams of 20% zinc oxide paste?

(a) The total amount of the preparation is _____ grams.

(b) 1 percent of the total amount is _____.

(c) _____X_____ = _____ grams of zinc oxide needed.

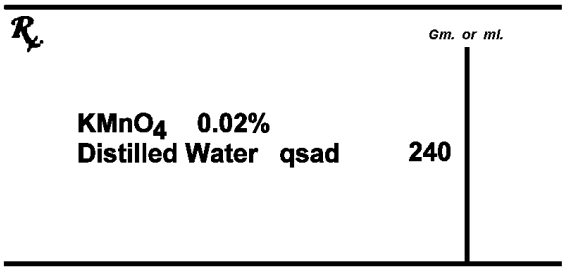
Solution:

(a) The total amount of the preparation is 120 grams.

(b) 1 percent of the total amount is 1.2.

(c) 1.2 X 20 = 24 grams of zinc oxide required.

(4) Example #4



How many grams of potassium permanganate ($KMnO_4$) are needed to compound the above prescription?

(a) The total amount of the preparation is _____ milliliters.

(b) 1 percent of the total amount is _____.

(c) X = grams of KMnO4 needed.

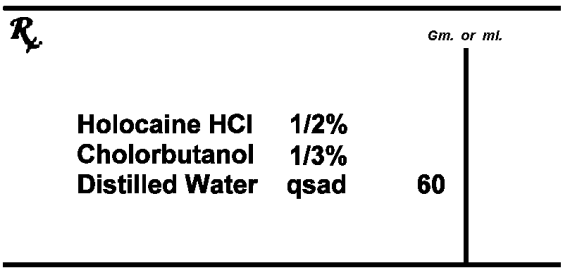
Solution:

(a) The total amount of the preparation is 240 milliliters.

(b) One percent of the total amount is 2.4.

(c) 2.4 X 0.02 = 0.048 grams of $KMnO_4$ needed.

(5) Example #5.



How many grams of holocaine hydrochloride and how many grams of chlorobutanol are needed to compound this prescription?

(a) The total amount of the preparation is _____ milliliters.

(b) One percent of the total amount is _____.

(c) ____ X ____ = _____ grams of holocaine HCl needed.

(d) ____ X ____ = _____ grams of chlorobutanol needed.

Solution:

(a) The total amount of the preparation is 60 milliliters.

(b) One percent of the total amount is 0.6.

(c) $0.6 \times 1/2 = \frac{0.6}{2} = 0.3$ grams of holocaine HCL needed.

(d) $0.6 \times 1/3 = \frac{0.6}{3} = 0.2$ grams of chlorobutanol needed.

d. Practical Exercise. Work the following exercises and check your answers.

(1) How many grams of boric acid will be needed to make 500 g of a 4% (w/w) ointment?

(2) How many grams of strong silver protein (SSP) are required to make 250 ml of a 0.25% (w/v) solution?

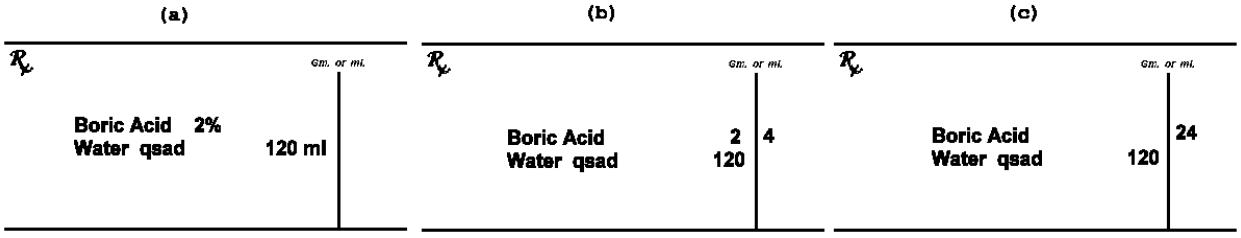
(3) How many grams of boric acid are there in 1 gallon of a 4% (w/v) boric acid solution?

(4) If 5 g of a chemical is dissolved in enough water to make the preparation measure one liter, what is the percentage strength of the solution?

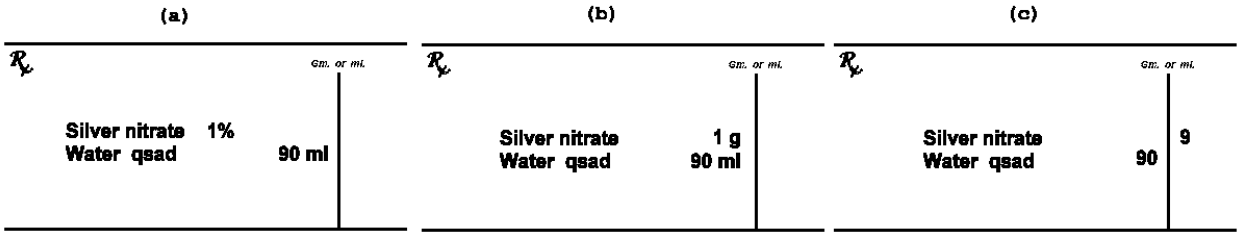
(5) How many milliliters of a 0.02% W/V solution can be made from 2.5 g of a chemical?

(6) Normal saline solution contains 0.9% W/V NaCl. How many grams of sodium chloride should be used to make 1.5 liters of normal saline?

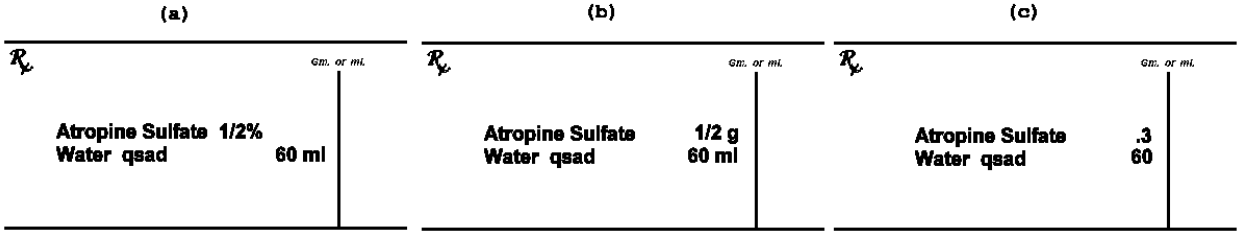
(7) Which of the following prescriptions calls for a different amount of boric acid from the other two?



(8) Which of the following prescriptions calls for a different amount of silver nitrate from the other two?



(9) Which of the following prescriptions calls for a different amount of atropine sulfate from the other two?



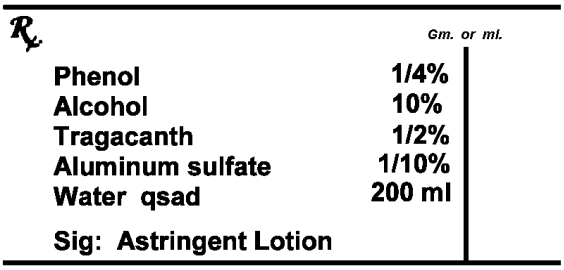
(10) Express the following ratio strengths as percentage strengths.

(a) 1:1,000

(b) 1:2500

(c) 1:40,000

(11) How many grams (or milliliters where appropriate) of each ingredient should be used in compounding the following prescription?

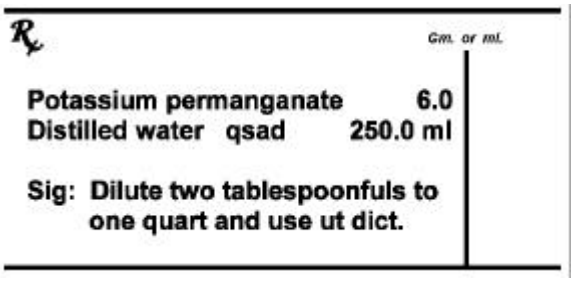


℞

	Gm. or ml.
Phenol	1/4%
Alcohol	10%
Tragacanth	1/2%
Aluminum sulfate	1/10%
Water qsad	200 ml

Sig: Astringent Lotion

(12)



℞

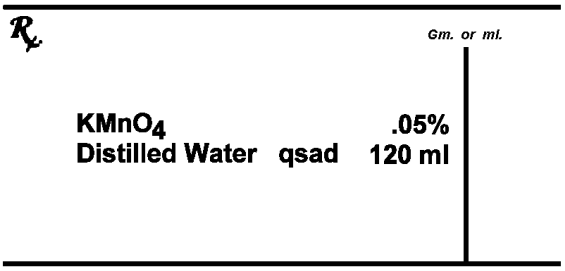
	Gm. or ml.
Potassium permanganate	6.0
Distilled water qsad	250.0 ml

Sig: Dilute two tablespoonfuls to one quart and use ut dict.

(a) What is the percentage strength of the prescription?

(b) What is the percentage strength of the final dilution?

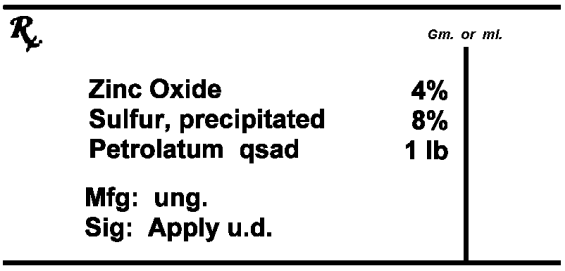
(13)



(a) How many grams of $KMnO_4$ are needed to make the above R_X?

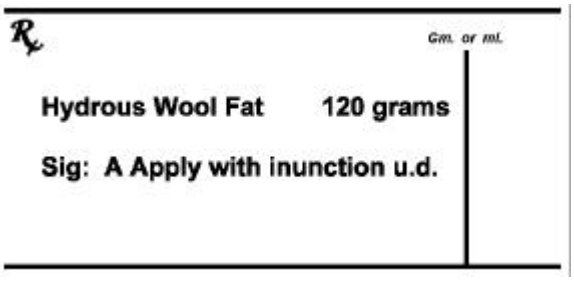
(b) How many milliliters of a 1:200 solution of $KMnO_4$ would be used to obtain the needed amount of $KMnO_4$?

(14)



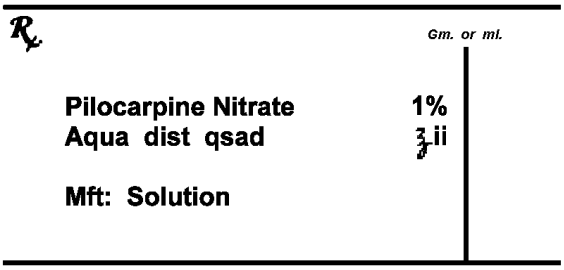
How many grams of zinc oxide and how many grams of sulfur are needed to compound the above prescription?

(15)

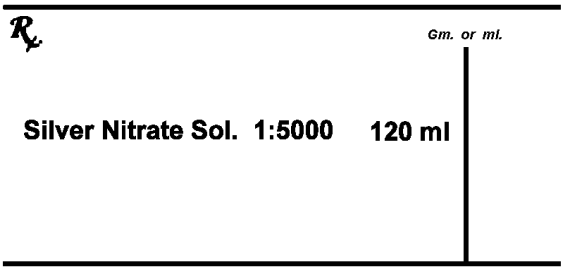


How many grams of wool fat and how many milliliters of water would be needed to fill a prescription for 120 grams? Hydrous wool fat contains 25% water and 75% wool fat.

(16) How many milligrams of pilocarpine nitrate would be needed to compound the following prescription?



(17) (a) How many milligrams of silver nitrate would be needed to compound the following R_x?



(b) You have a 1:500 stock solution of silver nitrate on the shelf. How many milliliters of it should be used to obtain the needed milligrams of silver nitrate?

e. Below are the answers to practical exercises. (reference paragraphs 2-5--2-6.)

(1) 20 g

(2) 0.625 g

(3) 151.4 g

(4) 0.5 g

(5) 12,500 ml

(6) 13.5 g

(7) (c)

(8) (b)

(9) (b)

(10) (a) Solution: $\frac{g}{1000\ ml} = \frac{x\ g}{100\ ml.}$ x = 0.1%

Remember: Percent means parts per 100 ml.

(b) 0.04%

(c) 0.0025%

(11) 0.5 ml phenol
20 ml alcohol
1.0 g tragacanth
0.2 g aluminum sulfate

(12) (a) 2.4%

(b) 0.0761% (can be rounded to 0.08%)

(13) (a) 0.06 g

(b) 12 ml

(14) 18.16 g zinc oxide
36.32 g sulfur

(15) 90 g wool fat
30 ml water

(16) 600 mg

(17) (a) 24 mg

(b) 12 ml

Section III. DILUTION OF STOCK PREPARATIONS

2-7. INTRODUCTION

Pharmacy personnel will often go to a stock solution to obtain the amount of active ingredient that is needed to make a preparation. This is especially true if the amount required is so small that it cannot be accurately weighed on a torsion balance. It is easier to measure an amount of stock solution than to set up a balance, weigh the ingredients, and compound the entire product. The use of stock preparations is an important aspect of pharmacy.

2-8. FORMULAS: In order for these formulas to work:

a. Volumes and weights must be expressed in the same units.

b. Concentrations must be expressed in the same units.

c. Formula: $V\ C = V_1\ C_1$

(1) V = Volume of stock preparation

(2) C = Concentration of stock preparation

(3) V_1 = Volume of desired preparation

(4) C_1 = Concentration of desired preparation

d. Formula: $W\ C = W_1\ C_1$

(1) W = Weight of stock preparation

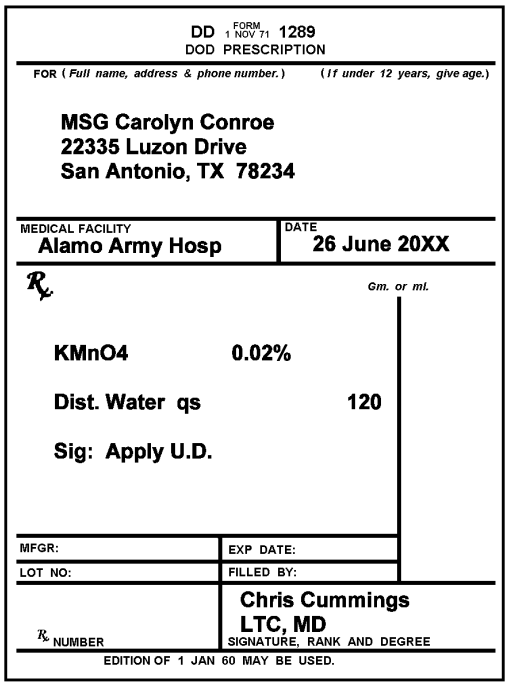
(2) C = Concentration of stock preparation

(3) W_1 = Weight of desired preparation

(4) C_1 = Concentration of desired preparation

2-9. EXAMPLE PROBLEMS

a. How many milliliters of a 2% stock solution of potassium permanganate ($KMn0_4$) would be needed to compound the following prescription?



DD FORM 1 NOV 71 1289
DOD PRESCRIPTION

FOR (*Full name, address & phone number.*) (*If under 12 years, give age.*)

MSG Carolyn Conroe
22335 Luzon Drive
San Antonio, TX 78234

MEDICAL FACILITY	DATE
Alamo Army Hosp	**26 June 20XX**

℞ *Gm. or ml.*

KMnO4 **0.02%**

Dist. Water qs **120**

Sig: Apply U.D.

MFGR:	EXP DATE:
LOT NO:	FILLED BY:
℞ NUMBER	**Chris Cummings LTC, MD** SIGNATURE, RANK AND DEGREE

EDITION OF 1 JAN 60 MAY BE USED.

USE THESE STEPS:

Step 1: Write the formula.

$$V\ C = V_1\ C_1$$

Step 2: Substitute values.

(X) (2%) = (120 ml) (.02%)

Step 3: Check units.

(a) Units of concentration are both percent.

(b) X will have the same units as the volume on the other side of the equal sign. In this case "milliliters."

Step 4: Solve for X.

2 X = 2.4

X = 1.2 ml (answer)

NOTE: To compound the prescription: Obtain 1.2 milliliters of the 2% stock solution of potassium permanganate, place it in a graduate, and "q.s." to 120 ml with distilled water.

b. How many grams of 14% zinc oxide ointment can be made from one pound of 20% zinc oxide ointment?

USE THESE STEPS:

Step 1: $W\ C = W_1\ C_1$

Step 2 & 3: (X) (14%) = (454 g) (20%)

Step 4: 14 X = 9080 X = 648.57142 grams (answer) (can be rounded to 648.57 grams)

NOTE: The one lb was changed to 454 grams because the answer is to be grams.

c. How many milliliters of 10% povidone-iodine (Betadine®) solution would be needed to make 4 liters of a 1:2000 Betadine® solution?

USE THESE STEPS:

Step 1: $V\ C = V_1\ C_1$

Step 2: $(X)\ (10\%) = (4\ L)\ \frac{(1)}{2000}$

Step 3: (a) Change 4 liters to milliliters

(b) Change 10% to a ratio by placing the 10 over 100.

$$(X)\ \frac{(10)}{100} = (4000\ ml)\ \ \frac{(1)}{2000}$$

NOTE: At this point, use the rule of mathematics that states that if both sides of the equal sign are multiplied by the same number, the sides will still be equal. The easiest way to simplify an equation having ratios on both sides of the equal sign is to multiply both sides of the equal sign by the larger denominator. In this case the larger denominator is 2000; therefore, multiply both sides by 2000.

$$(X)\ \frac{(20{,}000)}{100} = (4000\ ml)\ \frac{(2000)}{2000}$$

$$*200\ X = 4000\ ml$$

$$X = 20\ ml$$

*When zeros trail whole numbers on both sides of the equal sign, an equal number of zeros may be cancelled on each side without changing the value of the equation.

d. How many milliliters of a 1:200 silver nitrate solution would be needed to make 2000 ml of a 1:4000 solution?

$$V\ C = V_1\ C_1$$

$$(X)\ \frac{(1)}{200} = (2000\ ml)\ \frac{(1)}{4000}$$

$$(X)\ \frac{(4000)}{200} = (2000\ ml)\ \frac{(4000)}{4000}$$

$$20\ X = 2000\ ml$$

$$X = 100\ ml$$

e. Practical Exercises. Work the following problems and check your answers with the correct answers found in d (page 2-34).

(1) (a) How many milliliters of a 3% hydrogen peroxide solution would be needed to make 120 ml of 1% hydrogen peroxide solution?

(b) How many milliliters of water should be added?

(2) How many milliliters of a 5% potassium hydroxide solution would be needed to make 60 ml of a 2% potassium hydroxide solution?

(3) (a) How many milliliters of a 1:1000 epinephrine HCl solution are needed to make 30 ml of 1:5000 solution?

(b) How many milliliters of water would be added

(4) How many milliliters of a 1:50 stock solution should be used to prepare one liter of a 1:4000 solution?

(5) How many milliliters of a 2.5% stock solution of a chemical should be used to make 5 liters of a 1:1500 solution?

(6) How many milliliters of a 1:200 stock solution should be used to make 60 ml of a 0.025% solution?

(7) How many milliliters of a 1:50 stock solution should be used to make 250 ml of a 0.02% solution?

(8) How many milliliters of 10% (W/W) ammonia water can be made from 450 milliliters of 28% ammonia water?

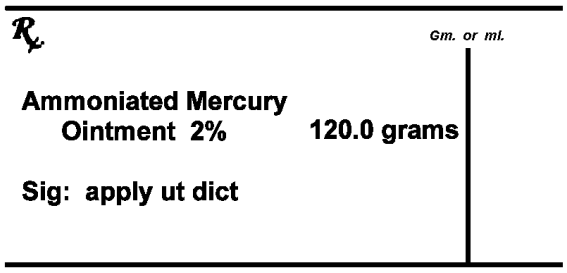
(9) How many gallons of 70% (V/V) alcohol can be made from 10 gallons of 95% (V/V) alcohol?

(10) How many grams of 2% ammoniated mercury ointment can be made from 1250 grams of 5% ammoniated mercury ointment?

(11) How many grams of 5% ichthammol ointment can be made from 5 lbs. of 15% ichthammol ointment?

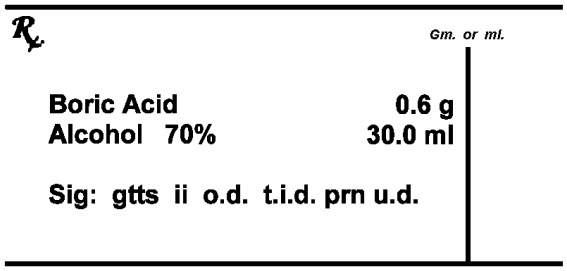
(12) How many 30 gram tubes can be filled from 5 lbs. of 10% ammoniated mercury ointment after it has been diluted to 3% in strength?

(13)

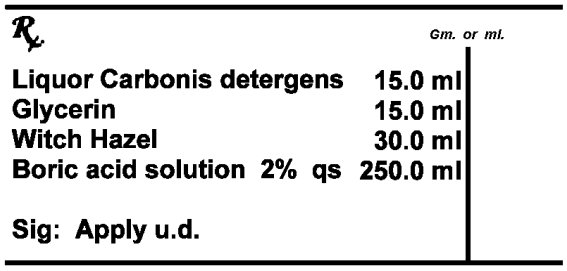


Prepare from 5% ammoniated mercury ointment. How much of the 5% ointment and how much of the diluent (petrolatum) should be used in compounding the R_x ?

(14) How many milliliters of 95% alcohol should be used in preparing the 70% alcohol needed for this preparation?



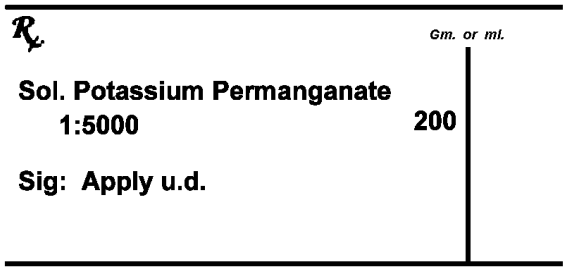
(15)



℞	Gm. or ml.
Liquor Carbonis detergens	15.0 ml
Glycerin	15.0 ml
Witch Hazel	30.0 ml
Boric acid solution 2% qs	250.0 ml
Sig: Apply u.d.	

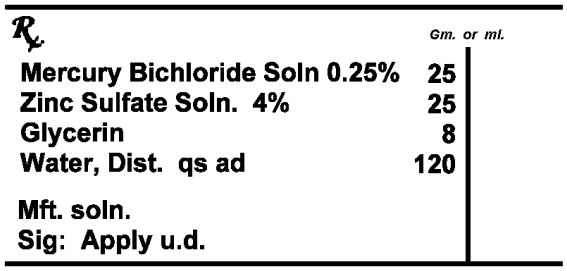
How many milliliters of a 5% boric acid solution should be used in compounding the R_x?

(16) How many milliliters of a 2% stock solution of potassium permanganate should be used in compounding the following R_x?



℞	Gm. or ml.
Sol. Potassium Permanganate 1:5000	200
Sig: Apply u.d.	

(17) How many milliliters of a 1:200 stock solution of mercury bichloride would be needed to compound the following prescription?



℞	Gm. or ml.
Mercury Bichloride Soln 0.25%	25
Zinc Sulfate Soln. 4%	25
Glycerin	8
Water, Dist. qs ad	120
Mft. soln.	
Sig: Apply u.d.	

d. Below are the answers to practical exercises (reference paragraphs 2-9).

(1) (a) 40 ml
(b) qsad 120 ml

(2) 24 ml

(3) (a) 6 ml
(b) qsad 30 ml

(4) 12.5 ml

(5) 133 ml (or 133.3 ml)

(6) 3 ml

(7) 25 ml

(8) 1260 grams

(9) 13.6 gallons

(10) 3125 grams

(11) 6810 g

(12) 252.2 tubes (rounded to 252 tubes)

(13) 48 g ointment
72 g petrolatum

(14) 22.1 ml

(15) 76 ml

(16) 2 ml

(17) 12.5 ml

Section IV. ALLIGATION

2-10. INTRODUCTION

Alligation is a method used to solve problems that involve mixing two products of different strengths to form a product having a desired intermediate strength. Alligation is used to calculate:

a. The amount of diluent that must be added to a given amount of higher strength preparation to make a desired lower strength.

b. The amounts of active ingredient which must be added to a given amount of lower strength preparation to make a higher strength.

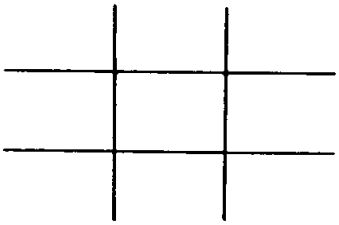
c. The amount of higher and lower strength preparations that must be combined to make a desired amount of an intermediate strength.

(1) It is often more practical to dilute a known strength preparation than it would be to compound an entire preparation. Compounding may involve weighing, measuring, heating, levitating, and extensive mixing of all the ingredients to achieve the finished product. Sometimes, a simple calculation using alligation allows us to calculate the amount of diluent to be added to an already prepared higher strength preparation to form the strength desired. The job would then be simplified by the combining of the two ingredients.

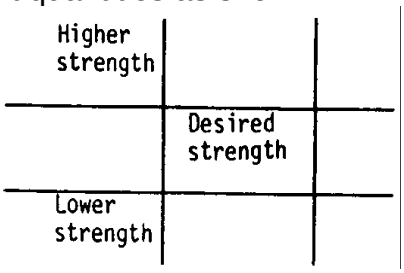
(2) Sometimes, it is necessary to increase the strength of a preparation by adding an active ingredient. If a doctor is treating a patient with 1-percent coal tar ointment and he decides to increase the strength to 2 percent, it can be accomplished by adding an unknown amount of coal tar (100 percent). Because this problem involves the mixing of a higher and a lower strength to form an intermediate strength, the unknown amount may be found by using alligation.

2-11. PROCEDURE FOR FINDING PROPORTIONS

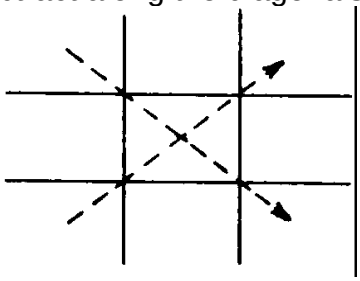
a. Draw a problem matrix



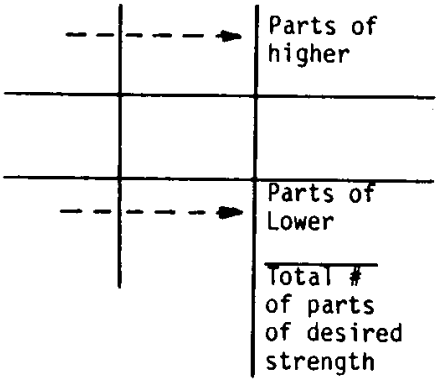
b. Insert quantities as shown.



c. Subtract along the diagonals.



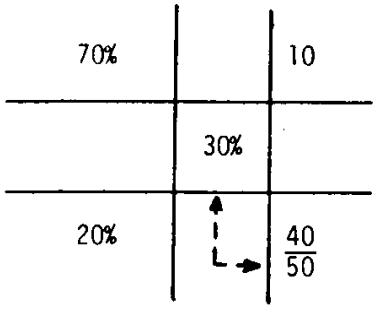
d. Read along the horizontals.



NOTE: The <u>desired</u> strength always goes in the center square of the matrix. The desired strength is the strength of the preparation that you want to <u>make</u>. <u>MAKE</u> is the key word in deciding the desired strength. Usually, the strength on the prescription will be the <u>desired</u> strength.

2-12. ALLIGATION PROBLEMS

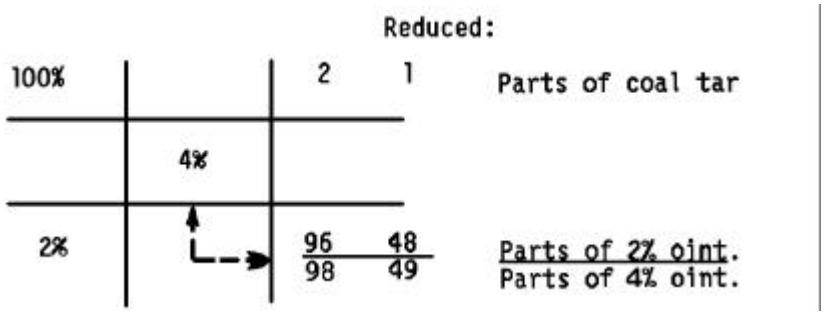
a. Example 1: A pharmacist has a 70% alcoholic elixir and a 20% alcoholic elixir. He needs a 30% alcoholic elixir to use as a vehicle for medications. In what proportion must the 70% elixir and the 20% elixir be combined to make a 30% elixir?



	Reduced:
10 parts of 70%	1 part of 70 %
40 parts of 20%	4 parts of 20 %
50 parts of 30%	5 parts of 30 %
	*

NOTE: *This means that if one part of 70% elixir is mixed with four parts of 20% elixir, it will yield five parts of 30% elixir. The dotted arrows in the matrix above have been placed as a reminder that the total number of parts always represents the desired strength.

b. Example 2: In what proportion must plain coal tar be combined with a 2% coal tar ointment to make a 4% coal tar ointment?



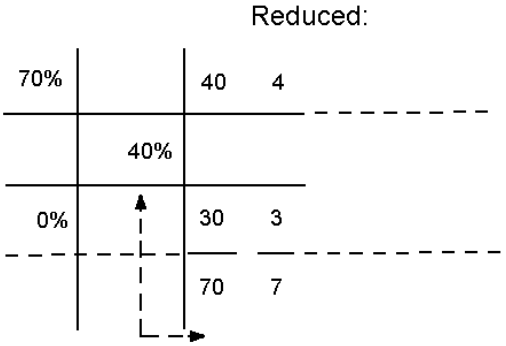
NOTE: Coal tar, because it is pure coal tar and not diluted, will be the higher (100 percent) strength.

If one part of coal tar is combined with 48 parts of 2% coal tar ointment, it will yield 49 parts of 4% coal tar ointment.

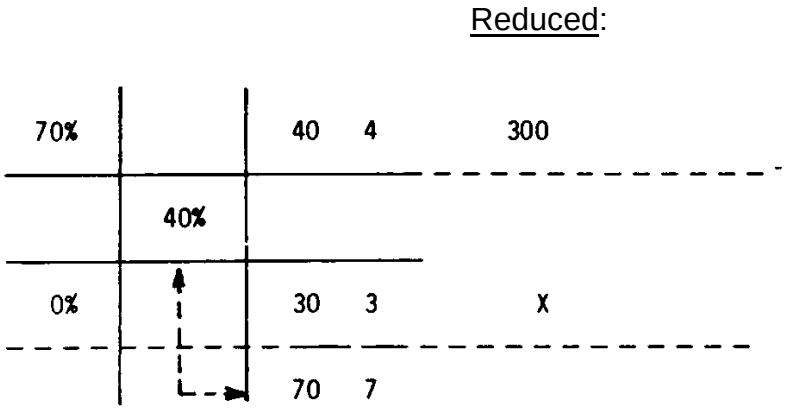
2-13. FORMULATING THE EQUATION USING THE MATRIX

a. Example: How many milliliters of water must be added to 300 ml of 70% alcoholic solution to make a 40% alcoholic solution?

(1) Before the matrix can be formed, the problem has to be analyzed to see which method is best for working the problem. The key words which indicate that this is an alligation problem are MUST BE ADDED TO. Other key words indicating alligation as the best method are MUST BE COMBINED and MUST BE MIXED. In this problem, 40% is the desired strength and must be placed in the center of the matrix. The next procedure is to see if a higher or lower strength is given. Seventy percent is a higher strength and must be placed in the upper left-hand corner of the matrix. If no lower strength is given, it can be assumed to be 0%. The matrix should be as follows:



(2) The relationship of parts of each parts strength to their combined final volume may be used as the first ratio of a proportion. To formulate the complete equation, place the known factors in the proper position on the matrix. Assign the X value first: The question asks, "How many milliliters of water?"; the X value is placed on the extended line opposite the percentage of alcohol denoted by water.



(3) The other known factor is that the water will be added to 300 ml of 70%. The 300-ml, because it pertains to the 70%, is placed on the line opposite the 70% on the matrix (see above). Once there are two values on the line and two values on another line, these values form the proportion.

$$\text{IF} \quad \frac{4}{3} = \frac{300}{X}$$

Cross Multiply:

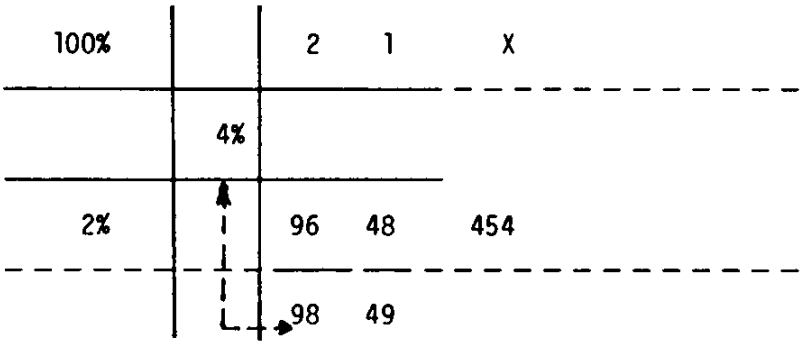
$$4X = 900$$

$$X = 225 \text{ ml of O\% (Water)}$$

NOTE: When distilled water, ointment bases, or normal saline are used as diluents, they will contain zero percent (0%) active ingredient.

b. Example 2: How many grams of coal tar must be added to one pound of 2% coal tar ointment to make a 4% coal tar ointment?

Reduced:



(1) This problem indicates a desired strength of 4% and a lower strength of 2%. If no other strength is indicated, it can be assumed to be 100 percent. Coal tar is 100% coal tar.

(2) Because the question asks, "How many grams of coal tar?" and coal tar is 100%, the X must be placed on the line opposite 100% (see above).

(3) The other known factor is that the coal tar must be added to one pound of 2% ointment. Because the answer is to be grams, the value one pound must be changed to 454 grams and placed on the line opposite 2%. Once two values are on one line and two values are on another line, these values will form the proportion.

$$\underline{\text{IF}} \quad \frac{1}{48} = \underline{\text{THEN}} \quad \frac{X}{454}$$

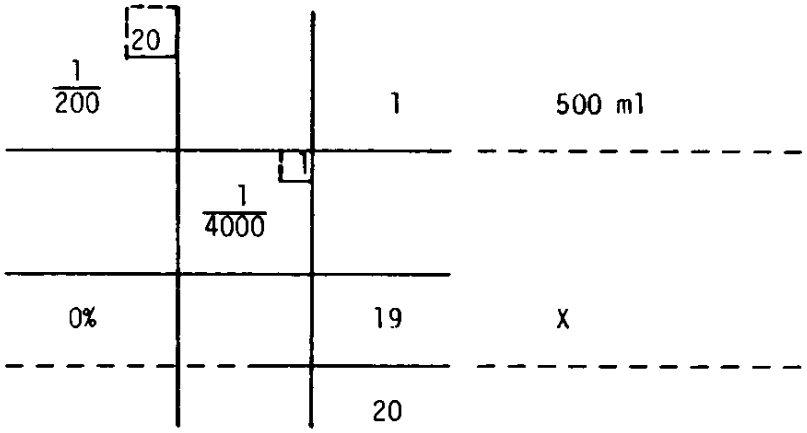
cross multiply

$48 X = 454$

$X = 9.4583333$ grams of coal tar (100%)
(can be rounded to 9.46 g)

Problems Involving Ratio Strengths:

c. Example 3: How many milliliters of water should be added to 500 ml of a 1:200 potassium chloride solution to make it a 1:4000 solution?



(1) The ratio strengths do not have to be changed to percentages to work this problem. Instead, they may be changed to whole numbers by multiplying each ratio by the largest denominator.

(2) The largest denominator of the two ratios in this problem is 4000, therefore each ratio should be multiplied by 4000.

$$4000 \times \frac{1}{4000} = \frac{4000}{4000} = 1$$

(3) The number 1 must be placed in the small square which has been added to the center square of the matrix (see above).

$$\text{Then} \quad 4000 \times \frac{1}{200} = \frac{4000}{200} = 20$$

(4) The number 20 must be placed in the small square which has been added to the higher strength square in the matrix (see matrix above).

(5) Once the fractions have been changed to whole numbers, solve the matrix using the whole numbers. Assign the X and other known value to the proper place on the matrix. The question should formulate the equation.

(6) Because the question asks, "How many milliliters of water?," and water is 0%, the X value will be placed on the 0% line. The 500-ml, because it pertains to the 1:200 solution, is placed on the 1:200 line (see paragraph 2-14c).

Then:

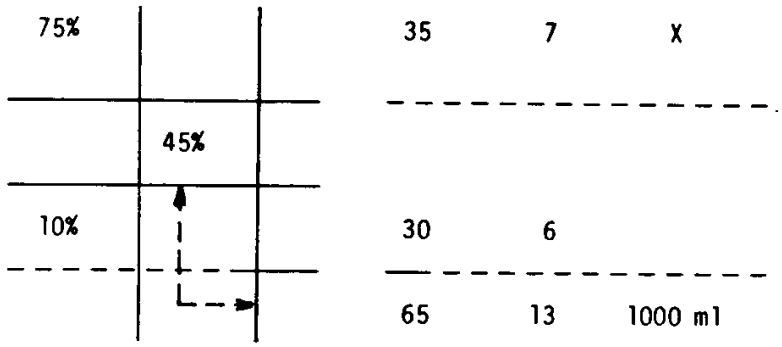
$$\text{IF} \quad \frac{1}{19} = \frac{\text{THEN}}{X} \quad \frac{500}{}$$

cross multiply

X = 9500 ml distilled water (answer)

d. Example 4: A pharmacist needs an elixir that contains 45% alcohol as a vehicle for medication. On hand, he has a 10% alcoholic elixir and a 75% alcoholic elixir. How many milliliters of the 75% elixir must be combined to make 1000 milliliters of 45% alcoholic elixir?

Reduced:



(1) When solving for the amount of both ingredients when the final volume is known, solve for the higher first. To solve for the higher, place the X on the line opposite the 75% (see above). The only other known factor is that 1000 milliliters of the 45% must be prepared. The 1000-ml must be placed on the line opposite the 45%. The arrow indicates that the bottom line is the 45% line (see above).

(2) Once two factors have been placed on two lines, use these factors to formulate the equation:

$$\underline{\text{IF}} \qquad \underline{\text{THEN}}$$

$$\frac{7}{13} = \frac{X}{1000}$$

$$13X = 7000$$

$$X = 538.46153 \text{ ml of 75\% elixir}$$
(can be rounded to 538.46 ml)

Then: 1000 ml total volume
-538.46 ml of 75%
461.54 ml of 10%

(3) Because there are only two elixirs involved in this preparation, if one value is known, the volume of the other ingredient may be found by subtracting the known volume from the final volume.

Or: The amount of 10% may be found by using the same matrix and by placing the X opposite the 10% on the matrix: Then the following factors must be used in the proportion:

$$\underline{\text{IF}} \quad \frac{6}{13} = \underline{\text{THEN}} \quad \frac{X}{1000}$$

cross multiply

$$13X = 6000$$

$$X = 461.53846 \text{ ml of 10\% elixir}$$
(can be rounded to 461.54 ml)

e. Practical Exercises. Work the following problems and check your answers with the correct answers found on page 2-42.

(1) How many milliliters of water must be added to 5 gallons of 100% isopropyl alcohol to make a 70% dilute Isopropyl alcohol?

ANS: _____ ml

(2) How many grams of coal tar and how many grams of 1% coal tar ointment must be combined to make 200 grams of 4% coal ointment?

ANS: _____ g coal tar

_____ g 1% ointment

(3) How many grams of coal tar must be added to 200 grams of 1% coal tar ointment to make a 4% coal tar ointment?

ANS: _____ g coal tar

(4) How many grams of 1% coal tar ointment must be added to 200 grams of coal tar to make a 4% coal tar ointment?

ANS: _____ g 1% ointment

(5) A 25% solution of ethyl alcohol may be used to bathe a small child for the purpose of cooling and reducing fever. How many milliliters of ethyl alcohol (95%) and how many milliliters of distilled water must be combined to make two quarts of the 25% ethyl alcohol solution?

ANS: _____ ml 95%

_____ ml water

(6) Terpin hydrate, an expectorant, is soluble in alcohol (40% or higher) but is insoluble in water. Should the alcohol concentration fall below 40%, the terpin hydrate will precipitate out of solution. Codeine sulfate is soluble in water but only slightly soluble in alcohol. Terpin hydrate and codeine sulfate are frequently used in combination in cough preparations. In order to allow both medications to remain in solution, the alcohol concentration must be 40% and 50%. How many milliliters of high alcoholic elixir (75%) and how many milliliters of low alcoholic elixir (10%) must be combined to make one gallon of 45% alcoholic elixir to be used as a vehicle for the two medications?

ANS: _____ml 75%

_____ml 10%

(7) How many milliliters of normal saline (diluent) must be added to one fluid ounce of 1-percent phenylephrine HCl solution to reduce the strength to 1/4%?

ANS: _____ ml normal saline

(8) How many milliliters of distilled water must be added to one liter of a 1:200 solution of potassium permanganate ($KMnO_4$) to make it a 1:4000 solution?

ANS: _____ ml distilled water

(9) How many grams of ointment base must be added to one 1b of 1% hydrocortisone ointment to make a 1/4% hydrocortisone ointment?

ANS: _____ g ointment base

f. Below are the answers to practical exercises (reference paragraphs 2-10 to 2-13).

(1) 8110.7142 ml (can be rounded to 8110.71 ml)

(2) 6.060606 g coal tar (can be rounded to 6.06g)
193.93939 g 1% ointment (can be rounded to 193.94 g)

(3) 6.25 g coal tar

(4) 6400 g 1% ointment

(5) 497.8947 ml 95% ethyl alcohol (can be reduced to 497.89 ml)
1394.1052 ml dist. Water (can be reduced to 1394.11 ml)

(6) 2038.0769 ml 75% elixir (can be reduced to 2038.08 ml)
1746.923 ml 10% elixir (can be reduced to 1746.92 ml)

(7) 90 ml normal saline

(8) 19,000 ml distilled water

(9) 1362 g ointment base

Continue with Exercises

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EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

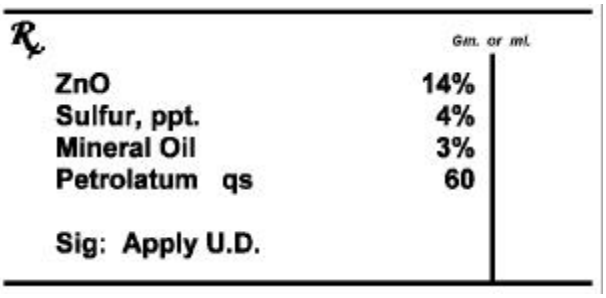
1. How many grams of coal tar must be added to 500 grams of a 1% coal tar ointment to make a 4% coal tar ointment?

ANS: _____ grams of coal tar

2. How many milliliters of water must be added to one quart of Zephiran® solution (17%) to make a 1:1000 solution?

ANS: _____ milliliters of water

3. How many grams of each ingredient are needed to compound the following prescription? The specific gravity of mineral oil is 0.85.



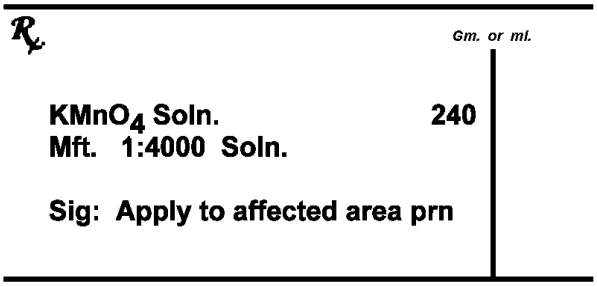
ANS: _____ g zinc oxide

_____ g sulfur, ppt

_____ g mineral oil

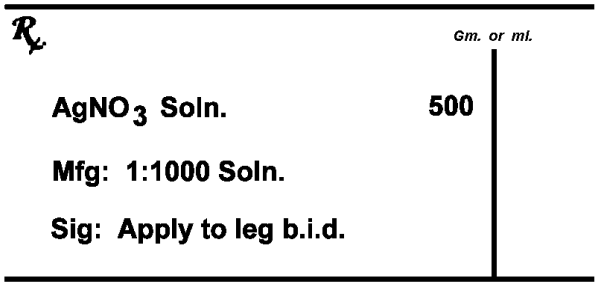
_____ g petrolatum

4. How many milliliters of a 2% $KMnO_4$ solution would be needed to compound this prescription?



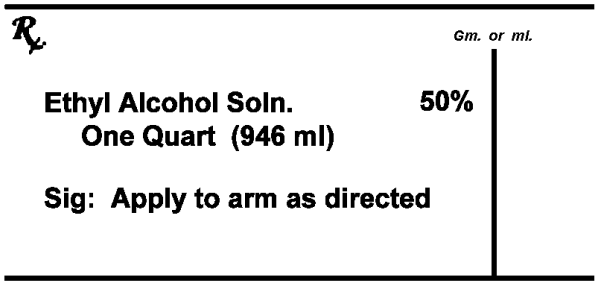
ANS: _____ ml of 2% Sol

5. How many milliliters of a 1-percent silver nitrate solution are needed to compound this prescription?



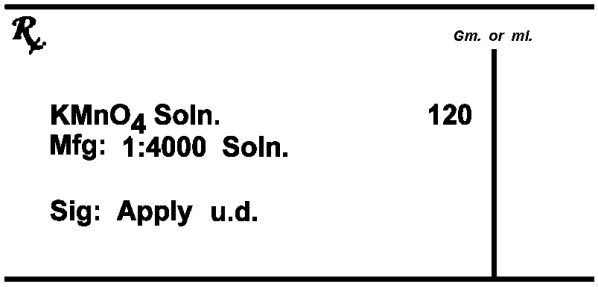
ANS: _____ml

6. How many milliliters of 95% ethyl alcohol would b needed to compound this prescription?



ANS: _____ ml of 95% Alcohol

7. (a) How many milligrams of potassium permanganate ($KMnO_4$) would be needed to compound this prescription?



ANS: _____ milligrams

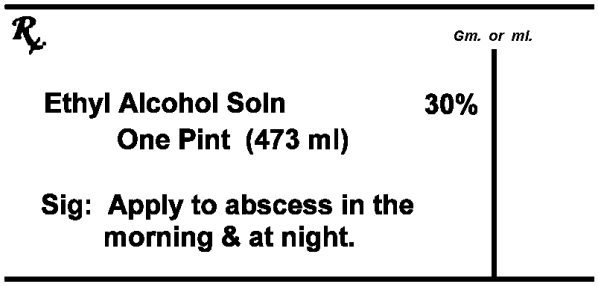
(b) How many milliliters of a 2% stock solution of potassium permanganate must be used to obtain the amount of active ingredient needed?

ANS: _____ milligrams

8. How many milliliters of distilled water must be added to one gallon of 100% Isopropyl Alcohol to make a 70% alcohol?

ANS: _____ milliliters

9. How many milliliters of 95% ethyl alcohol would be needed to compound this prescription?



ANS: _____ ml

10. How many grams of ointment base (diluent) must be added to one pound (454 grams) of 20% ZnO ointment to make a 10% ZnO ointment?

ANS: _____ grams of ointment base.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. Alligation: 15.625 grams (can be rounded to 15.63 g; para 2-12)

2. Alligation: 159,874 milliliters (para 2-13)

3. 8.4 g zinc oxide (para 2-3)
   2.4 g sulfur
   1.8 g mineral oil
   47.4 g petrolatum

4. 3 ml of 2% sol (para 2-8)

5. $V\ C\ =\ V_1\ C_1$ (para 2-8)

   50 milliliters

6. 497.89473 ml of 95% alcohol (can be rounded to 497.89 ml; para 2-13)

7. Ratio and proportion: (para 2-13)

   (a) 30 milligrams

   (b) 1.5 milliliters

8. Alligation: 1622.1428 milliliters (can be reduced to 1622.14 ml; para 2-13)

9. $V\ C\ =\ V_1\ C_1$ (para 2-8)

   149.36842 ml of 95% ethyl alcohol (can be rounded to 149.37 ml)

10. 454 Gm of ointment base (para 2-13)

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LESSON ASSIGNMENT

LESSON 3	Pharmaceutical Calculations III.
TEXT ASSIGNMENT	Paragraphs 3-1 through 3-5.
LESSON OBJECTIVES	After completing this lesson, you should be able to: **3-1.** Calculate the appropriate dose of a drug for a child using Fried's Rule, Young's Rule, Clark's Rule, and/or the Nomogram Method when given the recommended adult dose of the drug, the child's weight, age, and a nomogram. **3-2.** Calculate the appropriate dose for a patient when given the recommended dosage of that drug and the patient's weight in either pounds or kilograms.
SUGGESTION	After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

PHARMACEUTICAL CALCULATIONS III

3-1. INTRODUCTION

The therapeutic dose of a medication is based, generally, on its having a desired concentration in the patient's body. What is considered to be an ideal dose for an adult, when placed in the body of a small child, would give a concentration that is much greater than desired and could cause an adverse effect. Therefore, it is normally necessary to calculate a smaller dose for the child. This lesson will explain the methods used in pharmacy to calculate patient dosages.

3-2. WHAT IS A DOSE?

a. The term DOSE refers to the amount of medication that a patient must take at one time to produce the optimum therapeutic effect. The terms "average dose," "usual dose," and "adult dose" are based on the amount of medication needed to treat the average size adult (150-154 lbs.) with optimum effect. In order to make it easier to calculate dosages for other than average size patients, many drug manufacturers have established recommended doses based on the patient's weight or Body Surface Area (BSA). With this type of recommended dose, it is easy to calculate a dose for any size person using the same formula.

b. Examples of recommended doses:

(1) Pyrantel pamoate (Antiminth®) has a recommended dose of 11 mg/kg of body weight and is given in a single dose.

(2) Isoniazid (INH®) has a recommended dose of 450 mg/M^2/24 hours. The M^2 refers to one square meter of body surface area.

(3) Meperidine hydrochloride (Demerol®) has a recommended dose of 6 mg/kg/24 hours for pain and is given in divided doses four to six times daily. No single dose should exceed 100 mg.

3-3. PROBLEMS USING MANUFACTURER'S RECOMMENDED DOSE

Solution by ratio and proportion: (Example problems)

a. Cyclophoshamide (Cytoxan®) 50 mg tablets are used in the treatment of neoplasms (abnormal growths or tumors) and have a recommended dose of 5 mg/kg of body weight to be given in a single dose daily. How many tablets should be dispensed to a 110-lb patient as a ten-day regimen? (**NOTE**: A regimen is a treatment plan.).

(1) Find the dose for the patient in milligrams:

$$\frac{5 \text{ mg}}{1 \text{ kg (2.2 lbs)}} = \frac{X \text{ mg}}{110 \text{ lbs}}$$

$$2.2X = 550$$

$$X = \frac{550}{2.2}$$

$$X = 250 \text{ mg per dose}$$

NOTE: 1 kg was changed to 2.2 lbs. so that corresponding units of the proportion are the same. See lesson 1, para 1-40.

(2) Find the number of tablets to be dispensed per day:

$$\frac{1 \text{ tab}}{50 \text{ mg}} = \frac{X \text{ tab}}{250 \text{ mg}}$$

$$50X = 250$$

$$X = 5 \text{ tablets per day}$$

(3) Times 10 days:

10 x 5 tablets = 50 tablets required for a ten day regimen.

b. Meperidine HCl (Demerol®) is a synthetic narcotic analgesic having a recommended dose of 6 mg/kg/24 hours for pain and is given in divided doses at four to six hour intervals. The maximum single dose is 100 mg. How many milliliters of Demerol® injection (50 mg/ml) should be administered to a 33-pound child, who is suffering the pain of a broken leg, as a single dose every six hours?

(1) Find the daily dose in milligrams:

$$\frac{6 \text{ mg}}{1 \text{ Kg (2.2 lbs)}} = \frac{X \text{ mg}}{33 \text{ lbs}}$$

$$2.2X = 198$$

$$X = \frac{198}{2.2}$$

$$X = 90 \text{ mg of Demerol® per day}$$

NOTE: 1 kg was changed to 2.2 lbs so that corresponding units of the proportion are the same. For a review of this conversion factor, refer to paragraph 1-40b in lesson 1, section VI of this subcourse.

(2) Find the number of milliliters of Demerol® injection (50 mg/ml) needed as a daily dose:

$$\frac{50 \text{ mg}}{1 \text{ ml}} = \frac{90 \text{ mg}}{X \text{ ml}}$$

$$50X = 90$$

$$X = \frac{90}{50}$$

X = 1.8 ml every 24 hours.

(3) Find the number of milliliters to be administered every six hours:

$$\frac{1.8 \text{ ml}}{24 \text{ hours}} = \frac{X \text{ ml}}{6 \text{ hours}}$$

$$24X = 10.8$$

$$X = 108 \div 24$$

X = 0.45 ml of Demerol® injection to administered every six hours

3-4. PROBLEMS USING LABEL STRENGTH

In calculating problems involving the label strength, the label strength should be the first ratio of the proportion.

Example Problems:

a. If U-100 Insulin contains 100 units of insulin in each milliliter of suspension, how many milliliters must be administered to give a patient 60 units?

$$\frac{100 \text{ units}}{1 \text{ ml}} = \frac{60 \text{ units}}{X \text{ ml}}$$

$$100X = 60$$

$$X = 0.6 \text{ ml}$$

b. Tetanus antitoxin is an intramuscular or subcutaneous injection, given in a single dose ranging between 1500-10,000 units, as prophylaxis against tetanus. How many milliliters of tetanus antitoxin (1500 units/ml) must be injected to give the patient 2500 units?

$$\frac{1500 \text{ units}}{1 \text{ ml}} = \frac{2500 \text{ units}}{X \text{ ml}}$$

$$1500X = 2500$$

$$X = 1\ 2/3 \text{ ml or } 1.7 \text{ ml}$$

Work the following:

c. A Demerol® injection has a strength of 50 mg/ml. How many milliliters must be administered to give the patient 60 milligrams of Demerol®?

ANS: _____ ml

Solution to preceding problem:

$$\frac{50 \text{ mg}}{1 \text{ ml}} = \frac{60 \text{ mg}}{X \text{ ml}}$$

$$50X = 60$$

X = 1.2 ml of Demerol® injection should be administered.

3-5. FORMULAS INVOLVING "ADULT DOSE"

If it is necessary to calculate a dose for a child or an extremely large or small person and the only dose known is the adult dose or the usual dose, one of several formulas may be used. The formulas discussed in this lesson are all acceptable formulas for dose calculations. Though each formula listed yields a different dose for the patient, it must be understood that each answer is better than giving the adult dose. Formulas that deal with a patient's size have more value than the formulas dealing with age. An extremely small person, although 40 years old, would require less medication than the adult of average size.

a. Nomogram Method: The nomogram method is the best method because it is formulated on the patient's size. It takes into consideration the person's body surface area in meters square with 1.73 M^2 being the surface area of the average adult (150-154 lbs.).

(1) Formula:

$$\text{Child's } \frac{\text{surface area in } M^2}{1.73\ M^2} \times \text{Adult dose} = \text{Child's dose}$$

NOTE: If the height and weight of the patient are known, the surface area in meters square may be found by using the nomogram (See next page). Work the following problem by the nomogram method:

(2) Example problems:

(a) The adult dose of erythromycin is 250 mg to be given four times daily. Calculate the dose for a child who weighs 22 lbs. and is 30 inches tall.

ANS: _____ mg

(3) Solution to example problem 1:

Nomogram reading for the child is 0.46 M^2.

$$\text{Then: } \frac{0.46\ M^2 \times 250\ mg}{1.73\ M^2} = \frac{115\ mg}{1.73}$$

NOTE: The meter square cancelled.

$$\frac{66.5\ \text{mg}}{1.73 / 11500.} = \text{the child's dose}$$

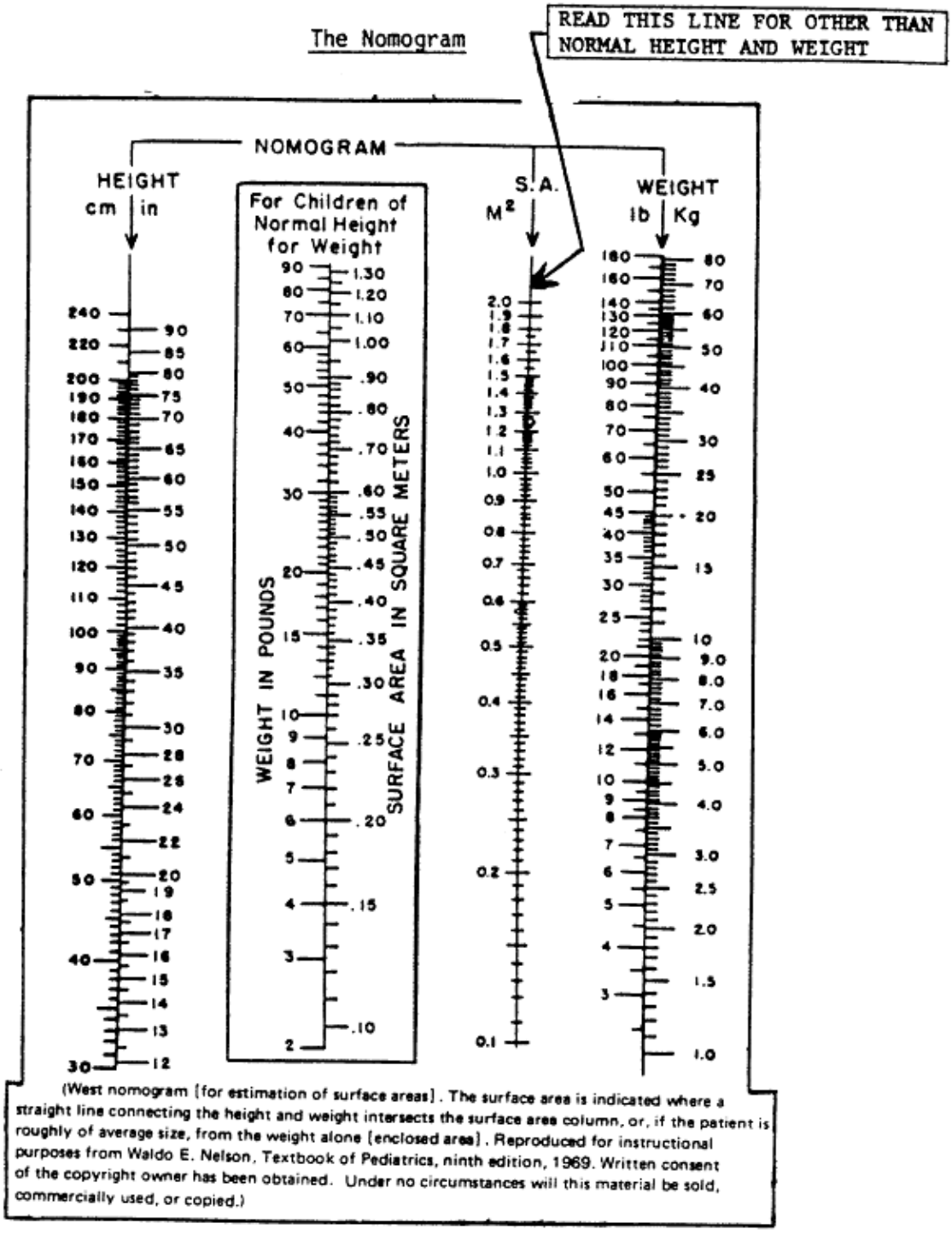
The Nomogram
READ THIS LINE FOR OTHER THAN NORMAL HEIGHT AND WEIGHT
NOMOGRAM
HEIGHT
cm | in
For Children of Normal Height for Weight
WEIGHT IN POUNDS
SURFACE AREA IN SQUARE METERS
S.A.
M²
WEIGHT
lb | Kg
(West nomogram [for estimation of surface areas]. The surface area is indicated where a straight line connecting the height and weight intersects the surface area column, or, if the patient is roughly of average size, from the weight alone [enclosed area]. Reproduced for instructional purposes from Waldo E. Nelson, Textbook of Pediatrics, ninth edition, 1969. Written consent of the copyright owner has been obtained. Under no circumstances will this material be sold, commercially used, or copied.)

Table 3-1. The nomogram

NOTE: If the child is of normal proportion, the center section may be used.

(4) Work the following:

The normal adult dose of promethazine (Phenergan®) is 25 mg. Using the nomogram, calculate the dose for a 40-lb child having an average build for his height.

ANS: _____ mg

(5) Solution:

NOTE: The meter square reading may be taken from the center chart of the nomogram if the child appears to be of average build.

The nomogram reading for a 40-lb child of average build is 0.75 M^2.

$$\text{Then: } \frac{0.75\ M^2}{1.73\ M^2} \times 25\ \text{mg} = \frac{18.75\ \text{mg}}{1.73} = 10.8\ \text{mg}$$

NOTE: The meter square cancelled.

NOTE: The following formulas or rules are acceptable in pharmacy, but have a lesser degree of accuracy than the Nomogram Method or the manufacturer's recommended dosage. You should become familiar with each rule and be able to use each if necessary.

b. Fried's Rule:

Child's dose = $\frac{\text{Child's age in months}}{150\ \text{months}} \times \text{Adult dose}$

(2) Example problem: The adult dose of an antihistamine is 50 mg. Calculate the dosage for a 2 ½-year-old child.

(3) Solution: $\frac{30\ \text{months}}{150\ \text{months}} \times 50\ \text{mg} = 10\ \text{mg}$

c. Young's Rule:

(1) Child's dose = $\frac{\text{Child's age in years}}{\text{Child's age in years + 12 years}}$ X Adult dose

(2) Example problem: The adult maintenance dose of a drug is 325 mg. Calculate the dosage for a 3-year-old child.

(3) Solution: $\frac{3}{3 + 12}$ X 325 mg = Child's dose

$\frac{3}{15}$ X 325 mg = 65 mg

d. Clark's Rule:

(1) Child's dose = $\frac{\text{Child's weight in lbs.}}{150 \text{ lbs.}}$ X Adult dose

(2) Example problem: The adult dose of Doxycycline is 100 mg. Calculate the dosage for a child weighing 50 pounds.

(3) Solution: $\frac{50 \text{ lbs.}}{150 \text{ lbs.}}$ X 100 mg = Child's dose

$\frac{1}{3}$ X 100 mg = 33.3 mg

Continue with Exercises

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EXERCISES, LESSON 3

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercises, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. U-100 Insulin contains 100 units of insulin per milliliter of suspension. How many milliliters of U-100 Insulin would you instruct a patient to administer if the physician wants him to have a dose of 35 units?

ANS: _____ ml

2. The adult dose of a drug is 10 milligrams per kilogram of body weight. How many grams should be given to a patient weighing 220 lbs.?

ANS: _____ g

3. The adult dose of ampicillin suspension is 250mg/5ml four times daily. If a child is 3 ft 6 inches tall and weighs 93 lbs., how many milligrams will she receive for each dose?

ANS: _____ mg

How many milliliters of the suspension should she take per dose?

ANS: _____ ml

4. If the usual dose of a drug is 200 milligrams, what would be the dose for an 8-year-old child who is 4-ft tall and weighs 80 lbs.?

ANS: _____ mg

5. The normal adult dose of dipenhydramine hydrochloride (Benadryl®) is 50 mg three times a day. What would be the daily dosage for a 5-year-old child who weighs 55 lbs. and is of average build?

ANS: _____ mg

6. The adult dose of Gantanol® is 0.5 g. What would be the dose, in milligrams, for a 10-year-old boy who is 5-ft tall and weighs 100 lbs.?

ANS: _____ mg

7. The adult dose of Lincocin®, an antibiotic used against gram positive bacteria, when given I.M., is 600 mg every 24 hours. How many milligrams should a child receive daily if she is 3-ft tall and weighs 35 lbs.?

ANS: _____ mg

8. The maximum adult dose of Periactin®, an oral medication used to control itching, should not exceed 16 mg per day. What would be the maximum daily dose for a child 4-ft 6-inches tall who weighs 88 lbs.?

ANS: _____ mg

9. The usual adult dose of acetaminophen (Tylenol®) is 10 gr. How many milligrams should a 3 year-old child receive who is 2-ft 6-inches tall and weighs 40 lbs.?

ANS: _____ mg

10. Referring to problem (9), if Tylenol® Elixir is preferred over the tablets for pediatric use, and contains 120 mg of acetaminophen per 5ml, how many ml should the child receive? (**NOTE**: Base your calculations upon the answer you obtained using the Nomogram Method.)

ANS: _____ ml

11. a. Meperidine HCl (Demerol®) has a recommended dose of 6mg/kg/24 hours for pain. What would be the dosage for a 110 lb. child?

ANS: _____ mg

b. How many milliliters of Demerol® injection (50mg/ml) must be administered at 4 hour intervals to give the patient the proper daily dose?

ANS: _____ ml

12. Isoniazid (INH®) tablets, an antitubercular agent, has a recommended dose of 450 mg/M^2/24 hours. What would be the daily dose for a child who is 5-ft tall and weighs 60 lbs.?

ANS: _____ mg

13. Ampicillin (Polycillin®) has a recommended child's dose of 100mg/kg/24 hours to be given at 6 hour intervals. You have received the following prescription.

DD FORM 1 NOV 71 1289
DOD PRESCRIPTION

FOR (*Full name, address & phone number.*) (*If under 12 years, give age.*)

Mary Jones (5 years old)
Dep of SP5 Roger Jones
103 Arbor Lane
Weight: 33 pounds

MEDICAL FACILITY	DATE
Alamo Army Hosp	**26 June 20XX**

℞ *Gm. or ml.*

Polycillin Suspension
125 mg/5 cc **qs**

Sig: One dose q.i.d.
x 10 days

MFGR:	EXP DATE:
LOT NO:	FILLED BY:
℞ NUMBER	**John Franklin** **LTC, MD** SIGNATURE, RANK AND DEGREE

EDITION OF 1 JAN 60 MAY BE USED.

a. What is Mary's weight in kg?

ANS: _____ kg

b. How many milligrams of ampicillin would be contained in a single dose?

ANS: _____ mg

c. How many milligrams would the patient take during the 10-day therapy?

ANS: _____ mg

d. What directions would you put on the label?

_____

e. How many milliliters of the suspension would you dispense?

ANS: _____ ml

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. 0.35 ml

2. 1 gram

3. 166.18 mg
   3.3 ml
   (**NOTE**: M^2 for patient is 1.15.)

4. Nomogram Formula:

   $\frac{1.2\ M^2}{1.73\ M^2}$ X 200 mg = 138.7 or 139 mg

   Fried's Rule:

   $\frac{96\ \text{months}}{150\ \text{months}}$ X 200 mg = 128 mg

   Young's Rule:

   $\frac{8\ \text{years}}{8\ \text{years} + 12\ \text{years}}$ X 200 mg = 80 mg

   Clark's Rule:

   $\frac{80\ \text{lbs}}{}$ X 200 mg = 106.6 or 107 mg

5. Nomogram Formula:

   $\frac{0.94\ M^2}{1.73\ M^2}$ X 150 mg = 81.5 mg

   Fried's Rule:

   $\frac{60\ \text{months}}{150\ \text{lbs}}$ X 150 mg = 60 mg

   Young's Rule:

   $\frac{5\ \text{years}}{5\ \text{years} + 12\ \text{years}}$ X 150 mg = 44.1 or 44 mg

   Clark's Rule:

   $\frac{55\ \text{lbs}}{150\ \text{lbs}}$ X 150 mg = 55 mg

6. Nomogram Formula:

$$\frac{1.4\ M^2}{1.73\ M^2} \quad \text{X 500 mg} = 404.6 \text{ or } 405 \text{ mg}$$

Fried's Rule:

$$\frac{120 \text{ months}}{150 \text{ months}} \quad \text{X 500 mg} = 400 \text{ mg}$$

Young's Rule:

$$\frac{10 \text{ years}}{10 \text{ years} + 12 \text{ years}} \quad \text{X 500 mg} = 227.27 \text{ or } 227 \text{ mg}$$

Clark's Rule:

$$\frac{100 \text{ lbs}}{150 \text{ lbs}} \quad \text{X 500 mg} = 333.33 \text{ or } 333 \text{ mg}$$

7. Nomogram Formula:

$$\frac{0.65\ M^2}{1.73\ M^2} \quad \text{X 600 mg} = 225.43 \text{ or } 225 \text{ mg}$$

Clark's Rule:

$$\frac{35 \text{ lbs}}{150 \text{ lbs}} \quad \text{X 600 mg} = 140 \text{ mg}$$

8. Nomogram Formula:

$$\frac{1.28\ M^2}{1.73\ M^2} \quad \text{X 16 mg} = 11.8 \text{ or } 12 \text{ mg}$$

Clark's Rule:

$$\frac{88 \text{ lbs}}{150 \text{ lbs}} \quad \text{X 16 mg} = 9.386 \text{ mg (can be rounded to 9.4 mg)}$$

9. Nomogram Formula:

$$\frac{0.65\ M^2}{1.73\ M^2} \quad \text{X 650 mg} = 244.22 \text{ or } 244 \text{ mg}$$

Fried's Rule:

$$\frac{36 \text{ months}}{150 \text{ months}} \quad \text{X 650 mg} = 156 \text{ mg}$$

Young's Rule:

$$\frac{3 \text{ years}}{3 \text{ years} + 12 \text{ years}} \quad \text{X 650 mg} = 130 \text{ mg}$$

Clark's Rule:

$$\frac{40 \text{ lbs}}{150 \text{ lbs}} \quad \text{X 650 mg} = 173.33 \text{ or } 173 \text{ mg}$$

10. 10.17 ml or 2 teaspoonfuls.

11. a. 300 mg

    b. 1 ml (**NOTE:** 4 hour intervals = 6 doses per day.)

12. 1.02 X 450 mg = 459 mg

13. a. 15 kg
    b. 375 mg
    c. 15,000 mg
    d. Take one tablespoonful four times daily
    e. 600 ml

(paras 3-3 through 3-5)

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